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Geography, Institutions and Human Development: A Cross-Country Analysis using Bayesian Model Averaging

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Abstract

This paper examines the role of long standing institutions – identified through geography, disease ecology, colonial legacy, and some direct measures of political and economic governance – on human development and its non income components across countries. The study employs a novel econometric technique called the Bayesian Model Averaging that allows us to select the relevant predictors by experimenting with a host of competing sets of variables. It constructs estimates as weighted average of OLS estimates for every possible combination of included variables. This is particularly useful in situations when there is *model uncertainty* and theory provides only a weak guidance on the selection of appropriate predictors. Of the 25 variables that we tried, three stand out in terms of their degree of importance and their robustness across various specifications. These include malaria ecology, KKZ index of good governance and fertility rate. Our finding on the dominant and robust role of malaria ecology in explaining differences in human development across countries, even in the presence of variables that directly and indirectly measure the quality of institutions, is extremely fascinating. It shows that malaria ecology has a direct negative impact on human development and this effect appears to be over and above its effect via institutions. Some of the other measures of climate and geography as well as those of colonial legacy are important as long as we do not control for some direct measures of the performance of political and economic institutions such as the KKZ index of good governance and democracy score. Once we control for these and other conditioning variables such as public spending on health and education; fertility rates; and measures of health infrastructure, the importance of geography and colonial legacy disappears.

JEL Classifications: I10; I12; I18; I28
Key Words: Human development; geography; institutions; Bayesian Model Averaging

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1. Motivation and objectives of the study

The central motivation of this study is based upon the insights developed from an in-depth analysis of the issues and challenges involved in human development in South Asia. In the aftermath of trade and market liberalization in the early 1990s, most countries in the South Asian region registered unprecedented rates of economic growth that exceeded 9 percent in India; 7 percent in Pakistan; 6 percent in Bangladesh and Bhutan; and 5 percent in Bangladesh. The benefits of such an impressive economic growth however, do not seem to have translated into concomitant improvements in human development indicators. The region continues to host the largest number of poor, illiterate and the malnourished people in the world (see e.g. Mahbub ul Haq Human Development Centre, 2007).

Although, poverty rates in all South Asian countries have declined, yet the rate of reduction in poverty have not matched that of economic growth. In fact, absolute poverty defined in terms of the number of poor, has merely registered 2 percent reduction, on average, per annum (from 527 million in 1993 to 423 million in 2004). In spite of overall declines in headcount poverty, the global share of South Asia in the total number of poor has increased from 40 percent in 1993 to 47 percent in 2004. Its share in the total number of illiterate adults in the world has also gone up from 46 to 49 percent during the same period. The enrolment rates have improved over the years, yet two countries in the region, India and Pakistan, continue to put up with the highest numbers of out of school children in the world. Malnutrition, particularly among children continues to be a serious problem with nearly one half of the children under the age of five estimated to be below their weight for age.

This lackluster performance of South Asia in terms of human development in the presence of high economic growth strengthens the view that the benefits of economic growth have been unevenly distributed across regions and across various socioeconomic groups within countries. The gains have largely been captured by relatively small, educated, urban based elite with the result that income inequality as measured by the Gini Coefficient went up in almost all South Asian countries between 1990 and 1995 (Mahbub ul Haq Human Development Centre, 2007). This scenario gives rise to the following critical question: If the gains of economic growth are not automatically translated into adequate improvements in human development, what are the factors that ensure they do?

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Intuitively, this takes us to the centrality of the role of institutions and the structure of political, economic and civic governance in explaining human development. If Amartya Sen (see e.g. Sen 2000) defines human development as the enlargement of choices and opportunities available to people and an expansion of their capabilities and freedom, then the achievement of this broader goal is hard to envisage without putting people at the centre. Institutions that lack transparency, accountability and freedom of speech, and that are weak in terms of enforcing property rights and contracts, are bound to promote the interests of a few powerful groups at the expense of others. In this sense, low investment in human development, poor social security arrangements, fiscal mismanagement and corruption; as well as uneven development and social exclusion are all symptoms of a much deeper malaise – succinctly described as the poor quality of institutions.

Most countries of South Asia as well as those in Middle East, and Sub Saharan Africa were formerly British, Portuguese, French colonies. The colonial rule left deep imprints on the culture as well as the formal and informal values, social norms, rules and regulations. The institutions developed by the colonists were largely meant to exploit the local subjects in order to promote the colonial interests. As countries gained independence from colonial rule, the key features of these institutions remained intact with the replacement of colonists by local elites. The exploitative features of these institutions facilitated these local elites to deny masses their rights and continue a culture of political patronage. In the case of South Asia for instance, political and economic power continues to be concentrated amongst a handful of elite groups. Dynastic politics and feudalism still thrive even in the presence of democracy, whereas ethnic and religious differences continue to be exploited leading to violence and social exclusion.

One may argue however, that not all countries that were former colonies have performed badly. Countries of Middle East, for instance are comparatively better ranked in some areas of human development than their neighboring countries in South Asia and Africa. Likewise, some of the highly developed countries such as the U.S.A and Australia were former colonies as well. The issue therefore may not be of whether or not a country has been a former colony, but whether the institutions developed in the past were exploitative or long lasting. In other words, the central question of our interest could be the type and the quality of institutions inherited from colonial rulers.

The question that arises then is how to measure the quality of institutions across countries. Recent empirical literature has used geographical variables that determine the disease environment to indicate the quality of institutions (see e.g. Easterly and Levine 2003). The central argument of this stream of literature is that the colonization strategy that the Europeans adopted in various countries depended upon the ecological conditions of the region. Countries that were located in temperate zones, and away from the equator were less prone to infectious diseases and had lower mortality rates. In these countries, Europeans preferred to settle and create better and long-lasting institutions that emphasized the protection of property rights and a system of checks and balances that are crucial in the effective functioning of governments. On the other hand, in countries where the settlers mortality was higher, Europeans did not settle but instead created 'extractive' institutions that promoted political and economic power (see Acemoglou et. al. 2001 (AJR) for more details). The key assumption behind using these historical factors to identify the present day quality of institutions is that the type and quality of institutions are persistent and that history and initial conditions have an important role to play in shaping the path of development that a country may take.

In recent years, a number of interesting studies have been conducted to investigate the impact of these long standing institutions – identified through geography and colonial legacy - on economic growth (see e.g. Hall and Jones 1999; Acemoglu et al. 2001). These studies employ a vast array of variables that capture geography (such as soil quality; distance from equator; latitude; and longitude), climatic conditions (such as temperate versus tropical location; and mean temperature) disease ecology (such as malaria ecology); and colonial legacy (such as whether or not the country has been colonized, the identity of colonizer: French or British, and the fraction of the people speaking any of the European languages).

However, no such study is conducted to investigate the impact of these institutions on a broader and a much more relevant indicator of human wellbeing such as the human development. A few studies that have been conducted on the role of institutions and human development (see next section for a comprehensive review) have mostly looked at the symptomatic variables - such as the absence or presence of democracy, civil and political liberties, government effectiveness, quality of governance, and corruption etc – and not on the structural and deeper parameters – such as colonial history and geographic variables – that determine the path of subsequent political, civil and economic institutions.

The present study uses advanced econometric techniques and a broad range of variables that are available to access geographical and ecological conditions; disease environment; and colonial history, to investigate the role of deep and structural factors - that are relatively predetermined and that define the broad contours of the type and quality of institutions – in human development across countries. In particular, we are interested in answering the following questions:

1. Does the quality of long standing institutions - as identified by colonial history, geography, climate, and disease ecology - matter for human development across countries?
2. Do geography, climate, and disease ecology have a direct impact on human development or does this effect merely run via institutions? A number of studies have found no direct impact of disease ecology and geographical location on *economic* development once institutions are controlled for (see e.g. Easterly and Levine 2002; and Acemoglu and Johnson et al. 2001). Is this true for a broader measure of development such as the *human* development?

The next section (section 2) presents a comprehensive review of literature. Section 3 discusses the sample and the selection of variables employed in the study. Section 4 presents some estimation preliminaries and some broad patterns emerging from the data. Section 5 outlines the econometric methodology employed and its relevance in providing answers to our research questions. Section 6 presents the estimation results and section 7 concludes.

2. Review of Literature

Institutions as defined by Douglass North (North, 1990) are humanly devised constraints that structure human interaction. They include formal institutions such as rules and regulations; as well as informal ones such as culture, mentalities, habits, trust, norms, conventions, codes and networks. Informal institutions are hard to capture although researchers have recently attempted to capture some of these aspects under the broad category of "social capital" or "social institutions". For the purposes of present study, our focus is on formal institutions that primarily fall under the broad categories of economic and political institutions. Economic institutions include, but may not be limited to the following: rule of law; property rights; contract enforcement; regulation of market externalities; fair competition; transparency;

accountability; macroeconomic stability that includes fiscal discipline, efficient taxation system and low inflation etc); and efficient delivery of public services that includes social welfare; social protection; education; health; social infrastructure. Political institutions, in general, encompass the type of political regime (such as democracy vs. authoritarianism); political stability and the absence of violence; constitutional structures (federalist vs. unitary state); and state capacities that include technical as well as administrative capacity of the state. Political institutions are complementary to the economic institutions and both are mutually reinforcing.

The indicators classified above under the broad categories of economic and political institutions are however performance indicators that capture certain aspects of an institutional system. Although these indicators have been used widely in cross section empirical studies particularly on economic growth, economists have come to realize the endogeneity of these indicators thereby limiting the precision and reliability of the econometric results (see e.g Doppelhofer, Miller and Sala-i-Martin, 2000). The idea is that indicators such as corruption and bad bureaucracy could very well be the response of poor economic performance. The same could very well be true for human development where political instability, violence, corruption, and bad bureaucracy may very well be the outcomes of low human development. The general idea of the whole story is that we need a much deeper, structural and a relatively pre-determined measure of the quality of institutions. Recently economists have used indicators of geography, climate, disease environment and colonial history to identify the quality of long standing institutions.

2.1 *From geography to institutions: key theoretical arguments and empirical studies*

As elaborated in section 1 above, geography, ecology, disease environment and colonial history have been used in the literature to identify the quality of long standing institutions. The advantage of using these variables as indirect measures of institutional quality is that they are predetermined and are more structural and deep in nature than some of the direct measures of political and economic institutions such as the democracy and governance indicators. The following are the key variables that are used as 'deep' measures of the quality of institutions:

2.1.1 Settler Mortality

This variable is measured by the logarithm of annualized deaths per thousand European soldiers during the early 19th century for 72 former colonies. The basic argument behind using this variable as a proxy for the quality of long standing institutions is that in regions where

settler mortality was high, Europeans did not settle and instead created 'extractive' institutions whereas in countries where settler mortality was low, they settled and created 'long-lasting' institutions. The key assumption behind this view is that European colonists adopted different colonization strategies that determined the quality of institutions that persisted even in the post independence period (see Acemoglu, Johnson and Robinson (AJR), 2001). AJR (2001) argued that post colonial governments of settler colonists were more democratic and defended property rights and rule of law, as compared to colonies where Europeans did not settle.

Using these measures of longstanding institutions, a number of empirical studies have found a significant and a robust role of institutions on the level and growth of per capita GDP across countries (see e.g. Hall and Jones, 1999; Easterly 2005; Easterly and Levine, 2003 and Acemoglu and Johnson et al., 2003). The data on this measure is however limited and studies that use several controls such as the present one, the sample size gets too small for any meaningful results

2.1.2 Tropical versus temperate climatic zones

Tropical vs. temperate geographic locations are found to affect development both directly as well as indirectly through institutions. According to Sachs (2000), of the thirty economies classified by the World Bank as high income, only two: Singapore and Hong Kong - that together contribute merely one percent of the population of rich economies - lie in the tropical regions. The direct impact of tropical climate on income runs through a number of channels that include low productivity of tropical soils; high prevalence of crop pests and parasites; lack of applicability of ecologically specific technologies developed in the temperate regions in the tropics; and favorable conditions for infectious diseases (see e.g. Diamond 1997). Tropical climate is also used as an indirect measure of the quality of institutions due to the same argument described above that tropical locations have historically been prone to infectious diseases leading to high mortality rates discouraging the European colonists to settle and create long lasting institutions. By this argument, tropical regions, in general, have poor quality of institutions compared to those of temperate regions

2.1.3 Land endowments

This hypothesis, attributed to Sokoloff and Engerman (2000), states that the long run path of institutional and economic development is greatly determined by the initial conditions or factor endowments. Countries with land endowment that is favorable to the production of those crops

- that require economies of scale and the use of slave labor - are historically characterized by the concentration of power among the population and landed elites. On the other hand countries with the endowment of land favorable to the production of crops such as wheat that can be produced by a family farm and does not require economies of scale, are associated with the growth of a large middle class in which power is distributed more widely. Sokoloff and Angerman (2000) argue that the resulting inequality due to differences in these endowments has led to the persistence of inequality since elites in these societies developed legal frameworks and rules that strengthened their power and resisted wider distribution and social and economic power. Easterly and Levine (2005) use agricultural endowments in the form of abundance of land for growing wheat relative to that suitable for growing sugarcane to predict inequality and long-term economic development. Using this pre-determined measure of inequality, Easterly and Levine (2005) find "inequality to be a large and statistically significant barrier to prosperity, good quality institutions and high schooling."

2.1.4 Disease ecology

Due to the availability of improved data on disease ecology particularly malaria, there has been a renewed interest in investigating the impact of malaria ecology on economic development. Jeffrey Sachs of the Earth Institute, Colombia is a prominent advocate of the direct role of malaria in economic development (see e.g. Sachs 2003). He argues that 41 out of the 44 countries with severe malaria lie in the bottom half of global ranking of countries with respect to GDP per capita. Economic growth in these countries has been dismal. Sachs argues that countries that have been able to eradicate malaria in past century have been able to grow much faster than growth in their region. He identifies a number of channels through which the prevalence of malaria has a direct effect on economic development. These include reduction in workers' productivity; increase in absenteeism both among teachers and students; premature mortality and increase in medical costs. According to Sachs, malaria consumes up to 25 percent of household income and 40 percent of the government health spending in Africa.

Acemoglu and Johnson et al. (2003), on the other hand argue that disease ecology do not have a direct effect on economic development. The only effect that they may have is through institutions. Long lasting institutions that protect property rights and are favorable to economic and social development are developed by colonists in those regions that had favorable disease ecology with low settler mortality. On the other hand, regions where disease ecology was prone

to malaria and yellow fever was fatal for European and in these regions, Europeans developed 'extractive' institutions resulting in the concentration of political and economic power. Acemoglu and Johnson et al. (2003) argue that some studies that explore the direct role of malaria have an omitted variable bias because malaria prevalence is correlated with European settlement and colonization strategies.

2.2 Institutions and Human Development: Empirical Studies

As mentioned in section 1 above, we do not find any study that looks at the role of any of the structural and deep measures of the quality of institutions on human development. Interestingly, we came across quite a few studies that examined the impact of democracy on child mortality rates and a few studies that primarily examined the impact of corruption and bad governance on some selected indicators such as child mortality, drop-out rates and public expenditure on health and education. These studies are briefly reviewed below:

2.2.1 Political institutions and human development

Political institutions have an instrumental significance in the formulation and implementation of public policies pertaining to the distribution of resources and the provision of public services such as health and education. Sen (2000), for instance, argues that participatory democracy that encourages public debate and discussion as well as civil and political rights has a constructive role in both the formation of values, norms and preferences as well as their translation into policies that benefit the society.

A number of cross country empirical studies have examined the role of political institutions in human development or its non income components (particularly infant and child mortality). Majority of these studies have looked at the type of political regime as a measure of the political institutions. Volmer and Ziegler (2009) for instance conducted a panel analysis corresponding to 1970-2003 and examined the relationship between democracy and the non income components of human development and found that democracy has a positive impact on life expectancy and literacy rates even after controlling for GDP. Several other empirical studies, mostly in the realm of political science, have found a significant positive effect - that is independent of the level of development - on child health outcomes (see e.g. Zweifel and Navia, 2000; Przeworski et al ,2000; Lake and Baum, 2001; Bueno de Mesquita, 2004; Besley and Kudamatsu, 2006; Franco and Ruiz, 2004; Tsai 2006; Ross, 2006).

A number of convincing arguments have been made in the literature regarding the mechanisms through which democracy is expected to promote greater human development. First, it is argued that in democracies the median voter is the decisive voter and in unequal societies, the income of the median voter is way below the mean income. The median voter collectively forces the government to redistribute income in favor of the poor (see e.g. Volmer and Ziegler, 2009). It is therefore argued that democracy tends to improve the distribution of a country's resources (see Tavares and Wacziarg, 2001; Boix, 2003; Mulligan and Sala-i-Martin. 2004; Acemoglu and Johnson, 2005;) and thereby fosters the wellbeing of the great majority of the population. Second, it is argued that since democracies are accountable to the people for their political survival, they have a greater tendency to address to the needs of the poor and to provide them with a wide array of opportunities. They promote higher manufacturing wages (Rodrik 1999), higher investment in human capital (Baum and Lake 2003; Stasavage 2005; Tavares and Wacziarg, 2001; Avelino and Hunter 2005), and a higher social welfare (Dasgupta 1993). Amartya Sen's famous contention that famines rarely occur in democracies (Sen 2000), is itself a convincing argument for the instrumental role of democracy in human development.

Despite these theoretical arguments and the plethora of empirical studies establishing a positive relationship between democracy and child mortality, there is still a lack of consensus on this issue. Ross (2006) for instance is highly critical of the studies that establish a positive link between democracy and child health outcomes. He argues that most of these studies do not control for country specific factors. There could be a possibility of some third factor that drives both the reduction in infant mortality and the greater prevalence of democracy. He argues further that reduction in mortality rates over time, due to technological advancements in public health, almost coincides with a dramatic rise in the prevalence of democracy. So there could be an 'exogenous health trend' that the existing studies fail to take into account. Ross (2006) also argues that most of these cross section studies suffer from selection bias as the majority of countries that have dictatorships may not have the required data. The study further contends that the poor on average may not be concerned about civil and political rights if it does not improve their material wellbeing. Democracies are not immune to elite capture of public resources. They may promote inequitable distribution of public resources whereby the benefits of public expenditure on

public services are captured more by the upper income groups than the lower income groups.

The subject of the link between democracy and human development therefore is still open for further work. Some of the limitations of earlier studies can be addressed by including sufficient control variables and by taking the discussion beyond the presence or absence of democracy to the quality and maturity of democracy and the technical and administrative capacity of the governments. The presence of democracy alone may not guarantee greater human development unless it is accompanied by strong democratic values and culture that includes civil and political liberties; a vibrant civil society that raises its voice effectively to get justice for the poor; a vocal and independent media that acts as a watch dog; effective mechanisms to hold governments accountable to the people such as an independent judiciary; and an electoral system that guarantees free and fair elections.

2.2.2 Corruption and human development

Corruption, broadly defined as the misuse of public office for private gain, is found to have a negative impact on human development through several ways. It reduces economic growth and the pace of poverty reduction. It increases military expenditures (see e.g. Gupta, and Sharan et. al., 2001) and has a negative impact on resources allocated for health and education (Mauro, 1998). It leads to leakages in public resources, including those that are allocated for health and education, and leads to an inefficient and inequitable allocation of these resources. Corruption is also found to be the primary factor behind low quality of education and health services. Cross country empirical studies have found that corruption has a negative impact on health and education indicators as measured by child mortality and immunization coverage on the one hand and literacy rate, school enrolment and drop-out rates on the other hand. Gupta and Davoodi et.al. (2000) for instance, conducted a cross section analysis of 128 countries for the period 1985-97 and found that corruption has adverse consequences on child mortality, percentage of low birth babies and drop outs in primary schools. In particular, the study found that child mortality rates in countries with high corruption are about one third higher than countries with low corruption. Infant mortality and percentage of low birth weight babies are twice as high; whereas drop-out rates are five times as high. Corruption is also found to be a contributing factor in fostering

educational, income and asset inequality (see e.g. Gupta and Davoodi et al., 1998) thereby exacerbating poverty.

Similarly, Akcay (2006) employed three different indices of corruption (Corruption Perception Index by Transparency International; International Country Risk Guide by Political Risk Services; and Corruption Index compiled by Kaufman, Kraay and Mastruzzi (2003)), conducted a cross country analysis of 63 countries and found a statistically significant negative relationship between corruption and human development. Corruption is inevitably a symptom of poor political and economic institution. Shleifer and Vishny (1993) suggest that government institutions and political process are a very important determinant of the level of corruption.

2.2.3 Good governance and human development

Studies on the role of good governance in human development have mostly examined the role of good governance in translating public expenditures on health and education in an efficient and equitable manner. Empirical studies have found a weak relationship between public expenditures and health outcomes implying that the governments on average are not efficient in terms of translating public expenditures into effective services (see e.g Filmer and Pritchett 1999; Filmer et al. 2000; Kim and Moody 1992; Musgrove 1996; Pritchett and Summers 1996). These studies further reinforce the argument that it is not merely fiscal outlays for health and education but the efficient, equitable and transparent utilization of these resources that matter for improvement in human development outcomes.

3. Sample and Variables

We conduct estimations for both the Human Development Index (HDI) as well as its non income components: the life expectancy and the combined gross enrolment rates. We do not use adult literacy rate as the available data on this variable is not adequate and after the inclusion of all control variables, our sample size is reduced further. We assume that the combined gross enrolment rate serves as a good proxy of educational attainment. For HDI as our dependent variable, our basic sample (sample A) consists of 72 countries, out of which 51 are developing countries. This sample is reduced further when we include data on income inequality. We include these two variables in a sub sample (sample B) that consists

of 58 countries, out of which 38 are developing countries. We report results for both these samples. For life expectancy as our dependent variable, the sample consists of 78 countries, out of which 57 are developing countries. For combined gross enrolment rates, we have a sample size of 66 countries, out of which 48 are developing countries.

Our dependent variable is the Human Development Index (2005) labeled as *hdi* reported in the Global Human Development Report prepared by UNDP (UNDP, 2009). This 2005 index is averaged over the five year period from 2000 to 2005 using a consistent methodology. We also report results on two other models in which we are interested in examining the determinants of non income components of the Human Development Index. The dependent variables in these models are the Life Expectancy *(lie)* and the Combined Gross Enrolment Ratios (*ger*), both taken from UNDP (2009).

In terms of potential explanatory variables, we first focus on variables that are either predetermined or exogenous or those that evolve slowly over time. To start with, we first estimate the impact of some key variables related to geography and climate. We also include some regional dummies in our initial set of estimations. To capture the role of geography, we make use of a well-known ecozone classification systems of the tropics, namely the Koeppen-Geiger (KG) zones. The variable of our interest is the share of a country's population that lives in a Koeppen-Geiger temperate zone (*kgptemp)*. This classification defines climatic boundaries based on vegetation types, temperature, and precipitation. Other researchers have also used zero one dummy for tropical location as well as variables that measure latitude and longitude. However, as pointed out by Sach's (2000), tropical or temperate ecozones are a rough characterization of a country's relevant ecological characteristics and a more useful definition of tropics should be based on ecological and climatic characteristics rather than the geographical characteristics. In this sense *kgptemp* is a superior measure as it classifies countries on the basis of both temperature as well as precipitation. We also use mean temperature *(meantemp)* as an additional measure of climate.

To measure disease ecology, we utilize the Malaria Ecology Index *(me)* – a comprehensive index constructed by Kiszewski and Sachs et al. (2004) that measures the intensity of malaria transmission based upon the biological characteristics of mosquitoes and the ecological conditions.

To access the role of colonial legacy, we use a number of measures that include colonial dummy on whether or not a country had ever been colonized (*colever*); the fraction of people speaking any of the major European languages (*eurfrac*). We also use the dummy for colonizer's identity. Since majority of the countries that were colonized in the past were either French or British colonies, we use *legbritish* (a dummy for whether or not a country was a British colony) and *legfrench* (a dummy for whether or not a country was a French colony).

We also make use of some well known and widely used measures of good governance and political institutions. To access the role of governance, we use a broad index of the quality of governance constructed by Kaufmann, Kray and Mastruzzi (2005). The index is formed by averaging across six measures of 1) Voice and Accountability (measuring political and civil rights); 2) Political stability and the Absence of Violence; 3) Government Effectiveness (measuring the competence of bureaucracy and the quality of bureaucracy); 4) Regulatory Burden (measuring the incidence of market unfriendly policies); 5) Rule of Law and 6) Control of Corruption (Kaufmann et al., 2005). This index is referred to as the KKZ index (*avgkkz*). A higher value of the index corresponds to high quality governance. For political institutions, we make use of the dataset compiled by Polity IV Project of the Center for International Development and Conflict Management at the University of Maryland. We use the Polity2 (*polity2*) score from this dataset that ranges from 10 (highly democratic) to -10 (highly autocratic). We also experiment with some other structural parameters that includes the measure of ethnic fractionalization (*ethnifrac*) and obtained from Alesina et al. (2003). The index measures the probability that two randomly selected individuals from a population belonged to different ethnic groups. Its theoretical maximum is reached at the value of one when each person belongs to a different group. Empirical studies have shown that ethnic and linguistic fractionalization is associated with inferior government performance. La Porte (1999) for instance finds that government performance, measured by a variety of variables including the quality of public goods such as health, education and infrastructure, is relatively poor in ethno-linguistic heterogeneous societies. The central theoretical argument is that in more ethnically heterogeneous societies, the ruling group has a tendency to limit the provision of public goods and restrict the other minority groups to benefit and get powerful. They also tend to restrict the freedom of opposition. Easterly and

Levine (2009) attribute much of the Africa's growth tragedy – reflected in negative growth, poor schooling, political instability, under developed financial systems and high government revenues – to Africa's high level of ethnic fragmentation. Easterly and Levine argue that a large part of differences in public policies, political instability and other factors associated with long term economic growth can be explained by cross country differences in ethnic diversity.

Other variables include the growth rate of Real GDP per capita in $PPP (*pengryc*) for 2005 obtained from Penn World tables. Since the level of GDP per capita is included in HDI by construction, we do not use it. To measure income inequality, we make use of the much superior data set on income inequality recently made available by Easterly (2005) in which data is adjusted by taking the average of each country of estimates from all sources over the period 1960-1998 (*giniadj*). This reduces the measurement error associated with income inequality data and serves as a good measure of initial inequality for the purposes of our study. We also use public spending on health as percentage of GDP (*hlthexp*) and public spending on education as percentage of GDP (*eduexp)* both obtained from World Development indicators by the World Bank. We take data lagged by five years on these two indicators so as to reduce the problem of reverse causality and to allow for the time lag required to translate public health and education expenditures into outcomes. Other conditioning variables that we use are immunization rates against DPT *(imdpt)*; the number of physicians per 1,000 population (*physc*), fertility rate (*frtrt*); the incidence of Tuberculoses per 100,000 population *(intub)* and the urbanization rate that is simply the growth rate of urban population (*urbnpopg*) all obtained from the World Bank data source.

4. Some Estimation Preliminaries

The scatter plots presented in Appendix 1 show some clear patterns emerging from the data. Among the variables related to geography and climate, malaria ecology and mean temperature seem to have a clear negative association with the Human Development Index (HDI). In particular, the slope of the fitted line between malaria ecology and human development is visibly steep. Interestingly, the association between human development and all components of good governance is clearly positive. Growth rate of real GDP per capita seems to have a very weak association with the HDI. Among other variables, fertility

rate and urbanization rate seem to be closely and negatively related to HDI. Policy variables such as public spending on health and health infrastructure, such as the number of physicians and immunization rates, are positively associated with HDI variables as expected. With regards to the Gini coefficient of income inequality, there is a negative pattern of association between the measures of inequality and human development emerging from the scatter plots. However, the scatter points do not seem to be tightly clustered across the fitted line and so the relationship appears to be rather weak. A negative association is also visible between HDI and ethnic fractionalization.

5. The Econometric Methodology

In order to test the relevance of a host of competing variables in explaining human development across countries, we will employ a novel econometric technique called the **Bayesian Model Averaging (BMA)** or **Bayesian Averaging of Classical Estimates (BACE)**. The reason for choosing Bayesian methods is that empirical research on human development, particularly in a cross country perspective is negligible. There are many candidate predictors, and theory provides only weak guidance on the specification of the regression. In other words, there is uncertainty regarding the choice of an appropriate model. Model uncertainty is a fundamental problem for empirical research in social science and the traditional response to this problem is to downplay it, select a set of suitable predictors and a single model and then base inferences on the basis of this model. The drawback of this approach is that it ignores model uncertainty. Ignoring model uncertainty lead to the impairment of predictive performance of the model and leads to overstatement of the strength of evidence via p-values that are too small (see Hoeting et al, 1999). The *Bayesian Averaging of Classical Estimates* (BACE) gets around with this problem by constructing estimates as weighted average of OLS estimates for every possible combination of included variables. For instance, if we restrict ourselves to linear regression models with explanatory variables drawn from a set of p predictors, where p is less than the number of countries, then there are 2^P possible models that can be estimated including the null model with only an intercept. The Bayesian methods estimate every possible model with different combination of predictors and then report the posterior probability of inclusion of different explanatory

variables in order of their importance. A higher inclusion probability of a variable indicates the higher importance of that variable in explaining the dependent variable. For instance, if Θ is the model parameter, then the posterior distribution of Θ is given by:

$$p(\Theta|Z) = \sum_{k=1}^{K} p(\Theta|Z, M_k)p(M_k|Z),$$

Where M= (M_1, M_2, …., M_k) is the set of models under consideration and Z is the given data. The estimation of posterior distribution is based upon the Bayesian Information Criteron (BIC). In order to investigate the hypothesis that a slope coefficient $\beta z \neq 0$, we sum up the posterior model probabilities for all models in which $\beta z \neq 0$. Similarly, we can also assess the weight of evidence that a coefficient is strictly positive by summing up the posterior model probabilities for all models in which $\beta z > 0$.

The advantage of using Bayesian methods is that it guides us in the selection of predictors and the appropriate model. It allows us to include and try an exhaustive set of predictors, a luxury that the Ordinary Least Squares does not allow as it runs into the risk of losing the precision of the model (through the reduction in the degree of freedom). It also allows us to examine robustness of variables across a wide range of specifications. Recent advances in computing power have made a Bayesian approach increasingly easy to adopt. Our study is the first to apply these methods to the examination of factors affecting human development across countries.

6. Estimation Results

6.1 Results from the Bayesian Approach

As mentioned in section 3 above, we have four different samples: The first two samples (one with income inequality and the other without) are used to examine factors that the affect the Human Development Index (HDI) across countries. The dependent variable in this specification is therefore the HDI. The other two samples are obtained to repeat the estimations to examine the determinants of non income components of HDI: the life expectancy and the combined gross enrolment rates. Using the methods describe in section 5, we compute posterior probabilities of inclusion of a variable, namely the sum of posterior model probabilities for all models in which a variable appears. We also

provide some indication of the sign of a relationship, based on the total posterior probability for models in which a variable acts in a given direction.

The estimation results are reported in Appendix 4. We start off with some fixed or exogenous factors such as the geographic location, climate, disease ecology and colonial history. These results are reported in column 1 of each table. In the next column, we include the remaining variables such as some direct measures of institutions (Governance Index; and democracy score from Polity2); policy variables (such as public spending on health and education; and health infrastructure); and other conditioning variables (such as growth of GDP per capita; initial income inequality; fertility rates and growth of urban population etc.)

Let us first examine the results for HDI. Starting off with some fixed factors such as regional location, percentage of population living in temperate zones, mean temperature, and malaria ecology, we find that percentage of population living in temperate zones (kgptemp) receives a very high posterior inclusion probability of 0.94. The positive sign indicates that HDI is higher on average for population living in temperate regions. Among the regional dummies, Sub-Saharan Africa and South Asian dummy receive the highest posterior inclusion probabilities of 1.0. The negative sign indicates unsurprisingly that HDI is poorer for people living in South Asia and Sub Saharan Africa. Western Europe has posterior inclusion probabilities of 0.83 with a positive sign. British colony also receives a very high posterior inclusion probability of 0.90 percent. The sign is positive indicating that HDI is positively associated with countries that have been British colonies in the past. Malaria ecology receives the posterior inclusion probability of 0.26 with a negative predicted sign indicating the HDI is negatively associated with malaria prone regions.

In the next column, when we add some direct measures of institution such as the KKZ Governance Index, Polity2 and other conditioning variables, interestingly, we find that the importance of climate and colonial legacy variables drops drastically with none of these variables receiving more than 0.14 of posterior inclusion probability. This indicates that geography, climate and colonial legacy affect HDI only though institutions and not directly. The most important variables, in order of their posterior inclusion probability turn out to be fertility rate (1.0), South Asia dummy (1.0) developing

countries dummy (1.0), malaria ecology (0.98), KKZ index of good governance (0.77) and Sub Saharan Africa dummy (0.68).

Of particular interest is the high posterior inclusion probability (with a negative predicted sign) of malaria ecology. This is despite the fact that we controlled for both direct as well as indirect measures of the quality of institutions. This vindicates Sach's (2003) contention that malaria has a direct role in development as opposed to Acemoglu and Johnson et al. (2003) who contend that malaria affects development only through institutions and not directly. Nevertheless, our variable of interest is the human development and not economic development per say as in Acemoglu and Johnson et al. (2003). This result is quite fascinating because the importance of malaria ecology does not decline (in fact increase further) in all our samples even when we use gross enrolment rates and life expectancy as the dependent variables. It does not receive the posterior inclusion probability of less than 0.98 in all the samples and in the presence of all controls.

The results do not change much with the inclusion of initial income inequality except for the fact that in addition to KKZ index of good governance, Polity2 also receives a high posterior inclusion probability of 0.78 in this sample. The predicted sign is positive indicating that democracy score is positively associated with human development across countries. Fertility rate and malaria ecology both receive posterior inclusion probabilities of 1.0. Initial income inequality receives posterior inclusion probability of 0.12 and the predicted sign turns out to be indeterminate.

Next, let us examine the results for our life expectancy equation (table 4.3). We have slightly modified the equation by dropping some irrelevant explanatory variables such as public spending on education and including other relevant variables such as the incidence of disease such as the Tuberculosis. Moreover, we also control for the level of real GDP per capita. According to the estimation results, the most important variables in degree of their posterior inclusion probabilities are the disease prevalence as proxied by the incidence of Tuberculosis (1.0), fertility rate (1.0), real GDP per capita (1.0), malaria ecology (1.0), East Asia and Pacific (0.94), French colony (0.98), and Sub Saharan Africa (0.97). Interestingly, the predicted sign for French colony turns out to be positive implying that countries that have been French colonies in the past seem to have higher

life expectancies on average. The other variables have predicted signs as expected. The KKZ index of good governance however loses its importance in the presence of real GDP per capita.

When we take gross enrolment ratio as our dependent variable, we include undernourishment rate and real GDP per capita as our additional controls. We drop public spending on health. The results, reported in table 4.4, are similar in many ways to the ones we obtained above. Malaria ecology again receives one of the highest posterior inclusion probability of 1.0. The other important variables, in degree of their posterior inclusion probability, are percentage of population living in temperate regions (0.99) democracy score as measured by Polity2 (0.98) East Asia and Pacific (0.95), Latin America and Caribbean (0.95); real GDP per capita (0.93); immunization against DPT (0.93); and public spending on education as % of GDP (0.36). The predicted signs for all these variables are as expected. Notice that when we control for GDP per capita, the importance of KKZ index of governance disappears. The results for gross enrolment ratios turn out to be a little different from the HDI and the life expectancy specifications in the sense that temperate location now receives a high inclusion probability, even in the presence of all controls, and the predicted sign is positive implying that gross enrolment rates are on average higher in temperate locations. Immunization rate also receives a reasonably high inclusion probability and the predicted sign is positive. Public spending on education also seems to matter a lot with higher spending associated with higher gross enrolment rates.

6.2 OLS Results

Bayesian methods are useful in terms of providing guidance in the selection of variables that have a high predictive power across an exhaustive set of model specifications. However, it does not help us predict the size of the impact of independent variables on dependent variables. In order to get some insight on the significance and size of the impact of independent variables on dependent variable, we conduct OLS estimations. The selection of the variables is based upon the posterior inclusion probabilities that they received in BMA results described in section 6.1. We select only those variables for

our OLS estimations that receive a relatively high posterior inclusion probability (greater than 0.2).

As in the case of BMA, we use four different samples (two for HDI as the dependent variable, one for life expectancy and one for gross enrolment ratio as the dependent variable. Before we present the OLS results, it is important to mention some caveats. First, since model selection is involved, therefore there might be a selection bias in the coefficient estimates. Moreover, since many of our explanatory variables are closely related to each other, it may not be straight forward to disentangle the effect of one variable from another. For instance, the KKZ index of good governance is highly correlated with real GDP per capita (partial correlation coefficient turns out to be 0.88). So in specifications where we cannot use GDP per capita as the explanatory variable (such as in the HDI equation), KKZ index may very well be picking up the role of income. For this purpose, the OLS results need to be interpreted with caution.

Table 4.3-4.5 present the OLS results across different specifications. As we can see clearly, the OLS results broadly support the insights we gained from our BMA estimations. The coefficient of malaria ecology is highly significant across all the specifications even after controlling for regional dummies, geography variable (percentage of population living in temperate zones) as well as governance and policy variables. The predicted sign is negative indicating that countries that have a high value of Malaria Ecology Index (countries that are more prone to malaria) have low human development. Notice that the size of the impact of malaria ecology (as depicted by the value of the coefficient estimate) is relatively small for HDI as compared to life expectancy and gross enrolment ratios. A one percent increase in Malaria Ecology Index for instance would lead to a reduction in HDI index by 0.03 percent on average, whereas the same increase in Malaria Ecology index would lead to a 1.3 percent reduction in life expectancy and 3.5 percent reduction in gross enrolment ratios. The coefficient of governance index is also significant and positive in majority of the specifications. However, once we control for the level of real GDP per capita, its impact dies out and the coefficient estimate is no longer significant. Fertility rate has a negative and a highly significant impact on both Human Development Index as well as life expectancy. It loses its statistical significance however in explaining gross enrolment ratios. It is interesting

to note that democracy score (Polity2) is highly significant in explaining gross enrolment ratios. The sign is positive implying that higher democracy is good for improving education across countries. Notice that real GDP per capita does not have a statistically significant impact on gross enrolment ratios whereas immunization rates have a positive and a statistically significant impact on gross enrolment ratios. As in BMA results, percentage of population living in KG temperate zones has a positive and statistically significant impact on gross enrolment ratios even after controlling for the level of GDP per capita and governance.

7. Conclusion

In recent years, a number of interesting studies have been conducted to investigate the impact of long standing institutions – identified through geography, disease ecology and colonial legacy - on economic growth or the level of GDP per capita. However, no such empirical study is conducted to investigate the impact of these institutions on a broader and a much more relevant indicator of human wellbeing such as the human development. This study aims to fill this critical gap by investigating the role of geography, institutions and disease ecology on human development and its non income components across countries. The study employs a comprehensive set of variables on geography, climate, disease ecology and some direct measures of political and economic institutions and uses a novel econometric technique called the Bayesian Model Averaging to study the role of each of these variables in affecting human development across countries. This econometric approach constructs estimates as weighted average of OLS estimates for every possible combination of included variables. Based upon this method, it computes posterior probabilities of inclusion, namely the sum of posterior model probabilities for all models in which a variable appears. A higher posterior inclusion probability of a variable indicates the higher degree of importance of that variable in explaining the dependent variable. The method also provides some indication of the sign of a relationship, based on the total posterior probability for models in which a variable acts in a given direction. The advantage of using this approach is that it takes into account model uncertainty particularly when theory provides only weak guidance on the selection of relevant variables. It also allows

us to include and try an exhaustive set of predictors, a luxury that a straight forward estimation of Ordinary Least Squares does not provide without running into the risk of losing the precision of the estimates.

We used three different specifications, each including a different measure of human development as the dependent variable. More specifically, we used the Human Development Index (HDI) and its non income components of life expectancy and combined gross enrolment rates as the dependent variable in each of these specifications. Out of an average of 25 variables that we tried for each equation, three variables stand out in terms of their importance and robustness in explaining both human development as well as its non-income components across countries. These include malaria ecology, KKZ index of good governance and fertility rate. Malaria ecology receives one of the highest posterior inclusion probabilities and this is true across all specifications of human development and in the presence of all controls including some direct as well as indirect measures of the quality of institutions. This indicates that malaria ecology has a direct negative impact on human development and this effect is over and above its effect on the quality of institutions. This turns out to be one of the most fascinating findings of our study.

Other geographic and climatic variables, particularly the percentage of population living in KG temperate zone are important as long as we do not control for some direct measures of the quality of institutions such as the KKZ index of good governance and democracy score; policy variables such the public spending on health and education; and other conditioning variables such as the fertility rate, immunization coverage and growth in urbanization etc. As soon as we control for these variables, the importance of geography and climate disappears. Same is true for colonial legacy. British and French legacy as well as fraction of population speaking any of the European languages turn out to be important initially. However once we control for the direct measures of the performance of economic and political institutions, colonial legacy does not matter anymore.

The KKZ index of good governance is positively associated with the human development. This index measures various aspects of the performance of political and economic institutions. It is the average of six indices namely :1) Voice and

Accountability (measuring political and civil rights); 2) Political stability and the Absence of Violence; 3) Government Effectiveness (measuring the competence of bureaucracy and the quality of bureaucracy); 4) Regulatory Burden (measuring the incidence of market unfriendly policies); 5) Rule of Law and 6) Control of Corruption. The significance of these measures of political and economic governance has been pointed out earlier in some studies, particularly in a number of global, regional and national Human Development Reports prepared by the UNDP, yet to the best of our knowledge, this is the first study that points to the direct empirical relationship between human development and good governance. The importance of KKZ index of good governance is however not robust to the inclusion of real GDP per capita. This implies that good governance index may very well be capturing the role of real GDP per capita in explaining life expectancy and gross enrolment ratios across countries. The finding that fertility rate is closely and negatively associated with the human development across countries is also an extremely useful finding from a policy perspective.

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Appendix 1: Scatter Plots

Figure 1

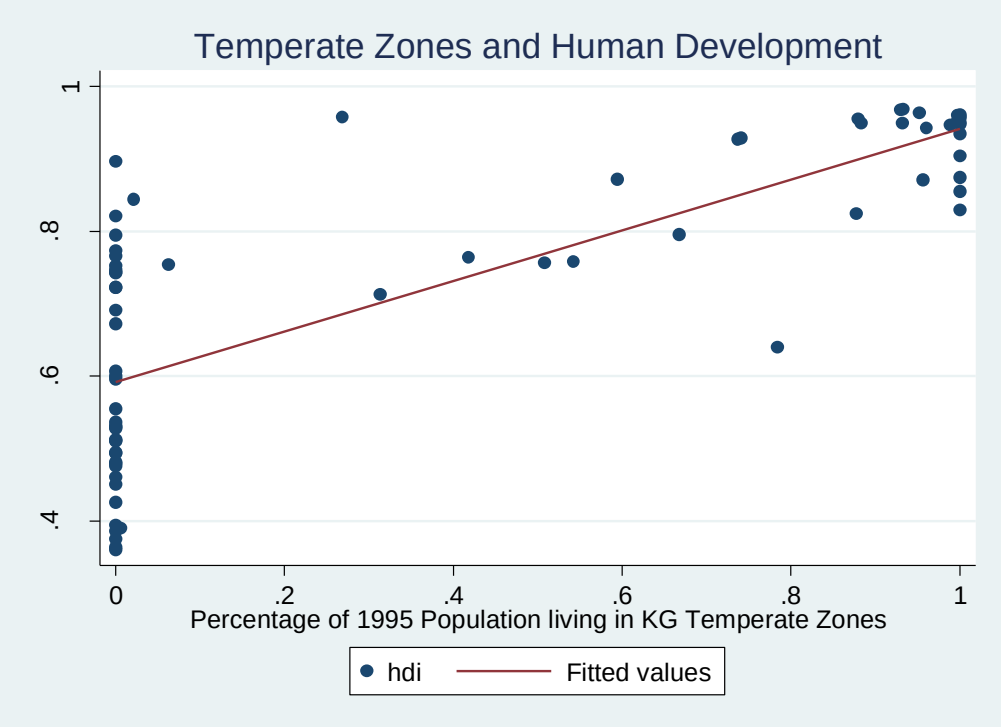


Figure 2

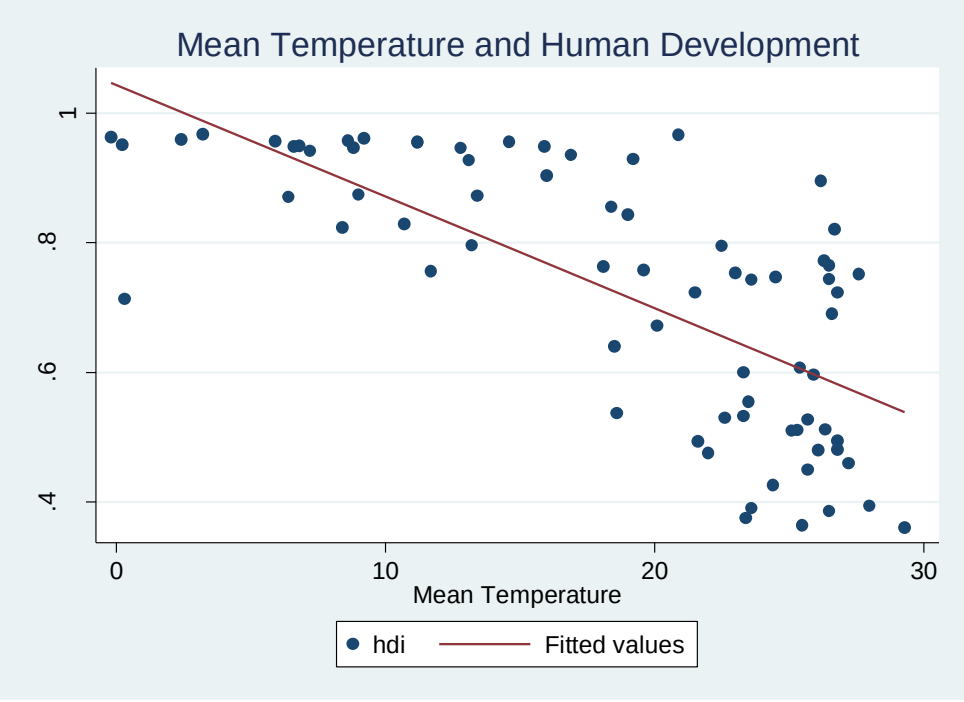


Figure 3

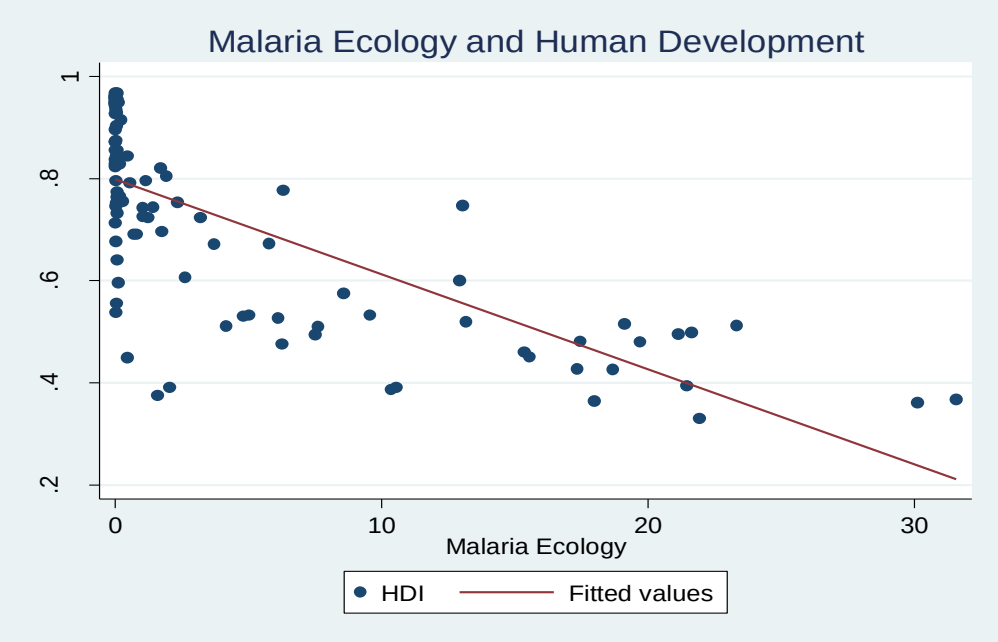


Figure 4

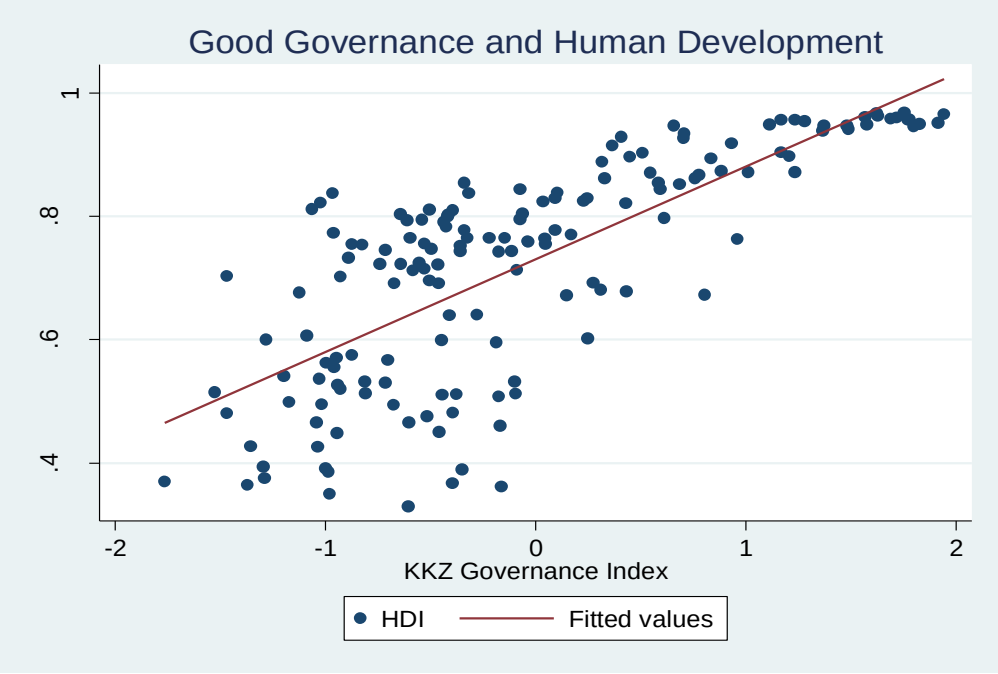


Figure 5

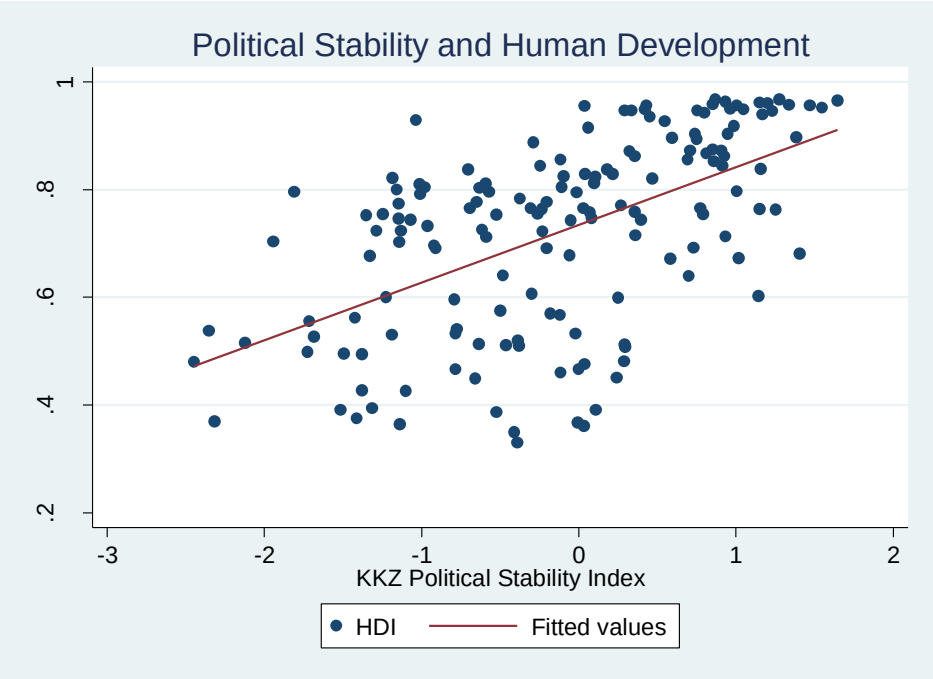
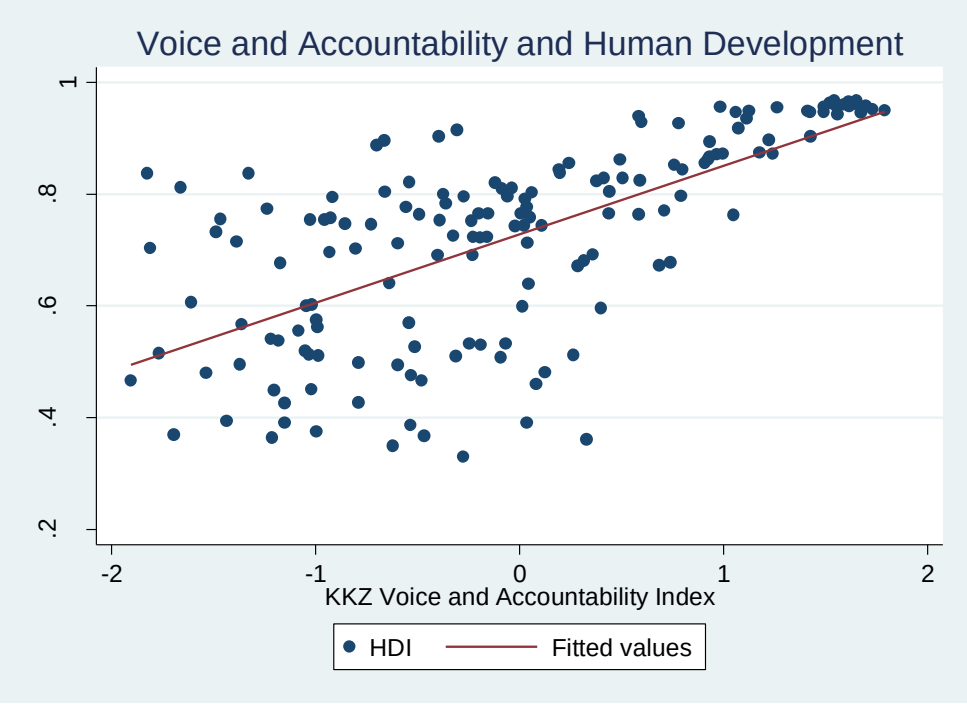


Figure 6



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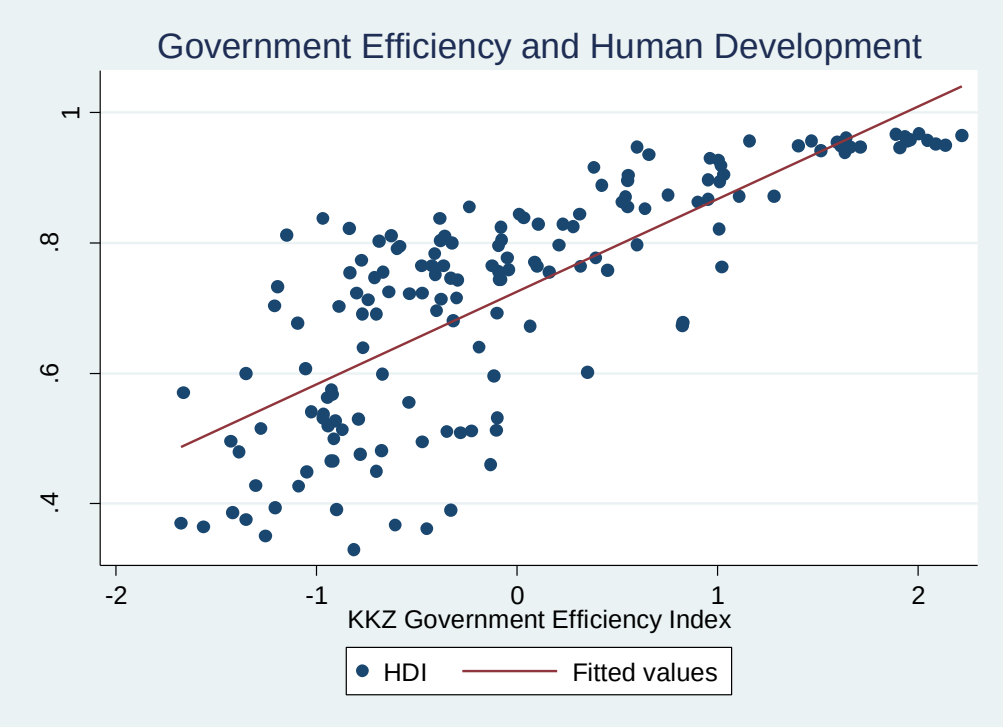

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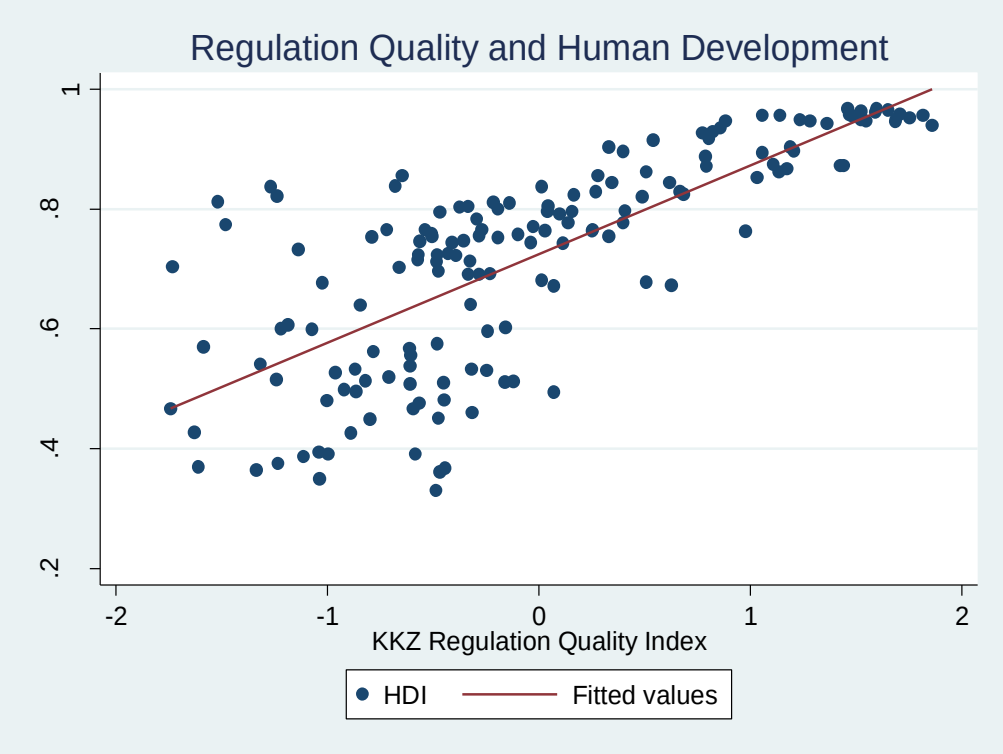


Figure 8

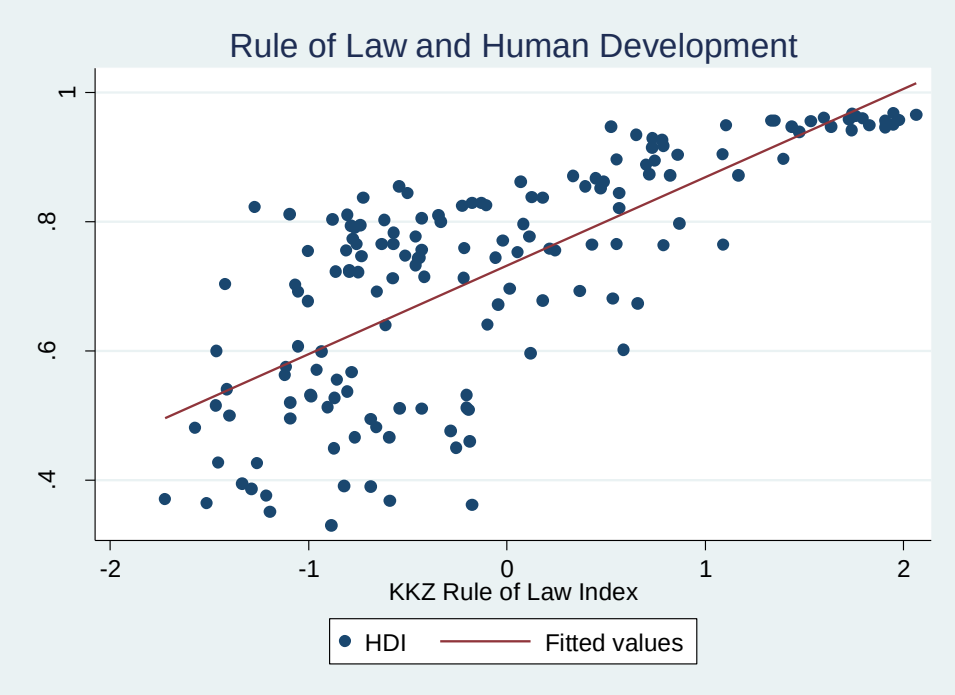


Figure 9

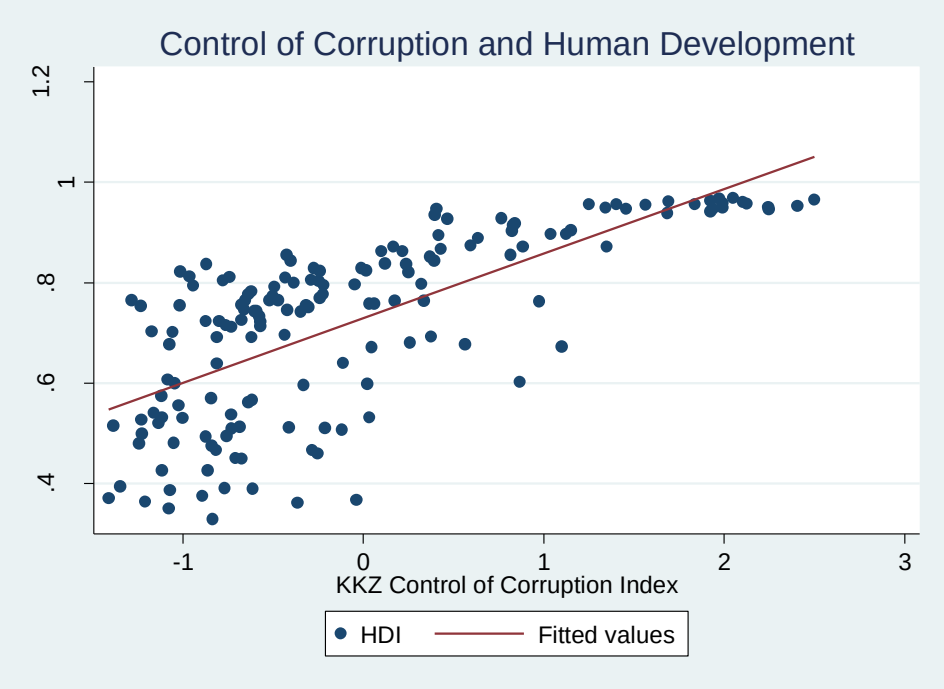


Figure 10

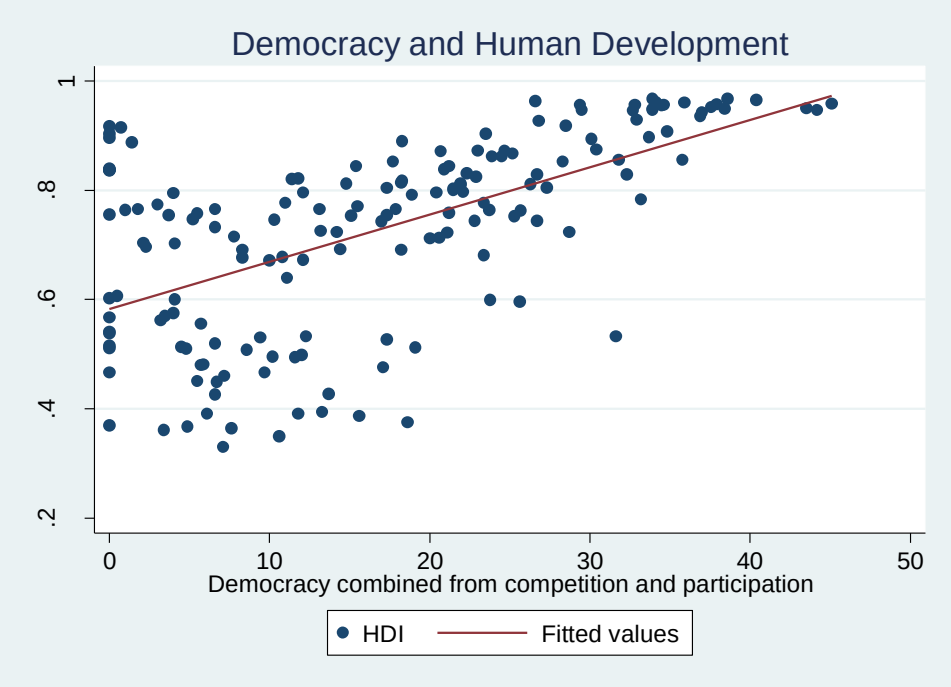


Figure 11

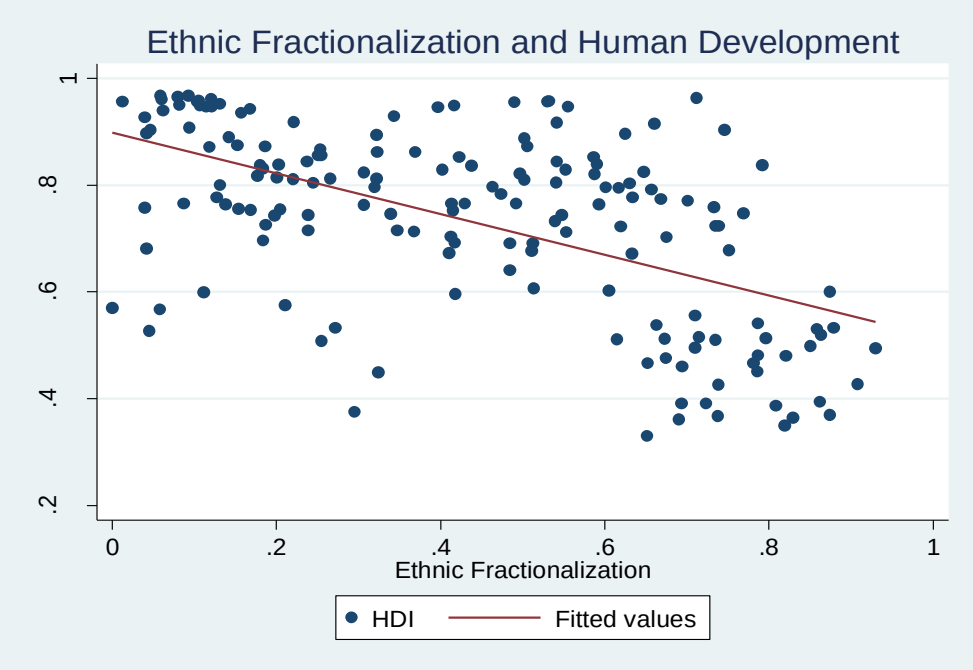


Figure 12

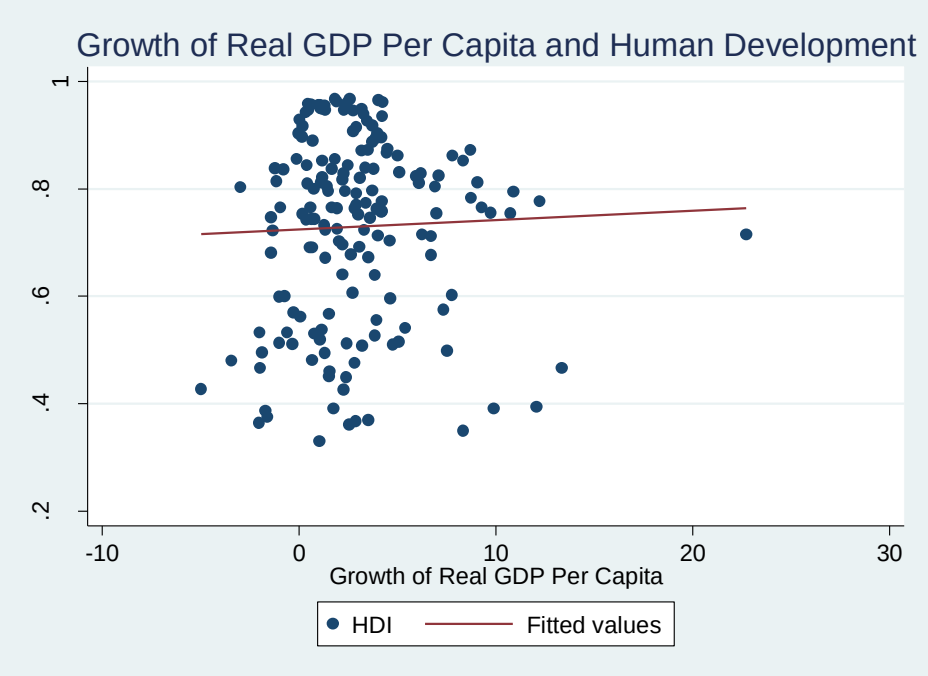


Figure 13

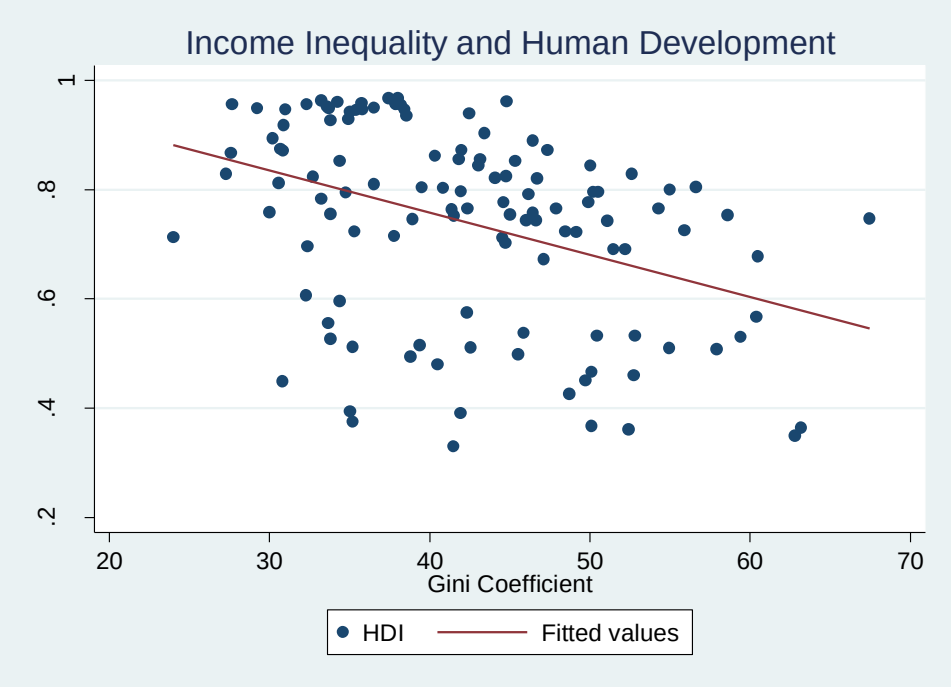


Figure 14

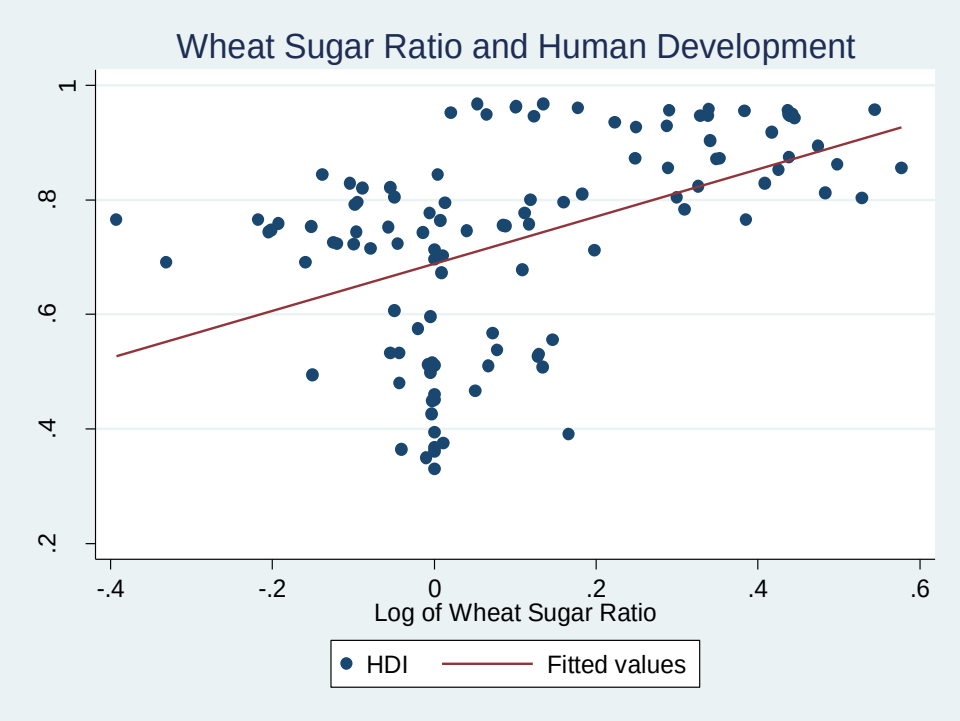


Figure 15

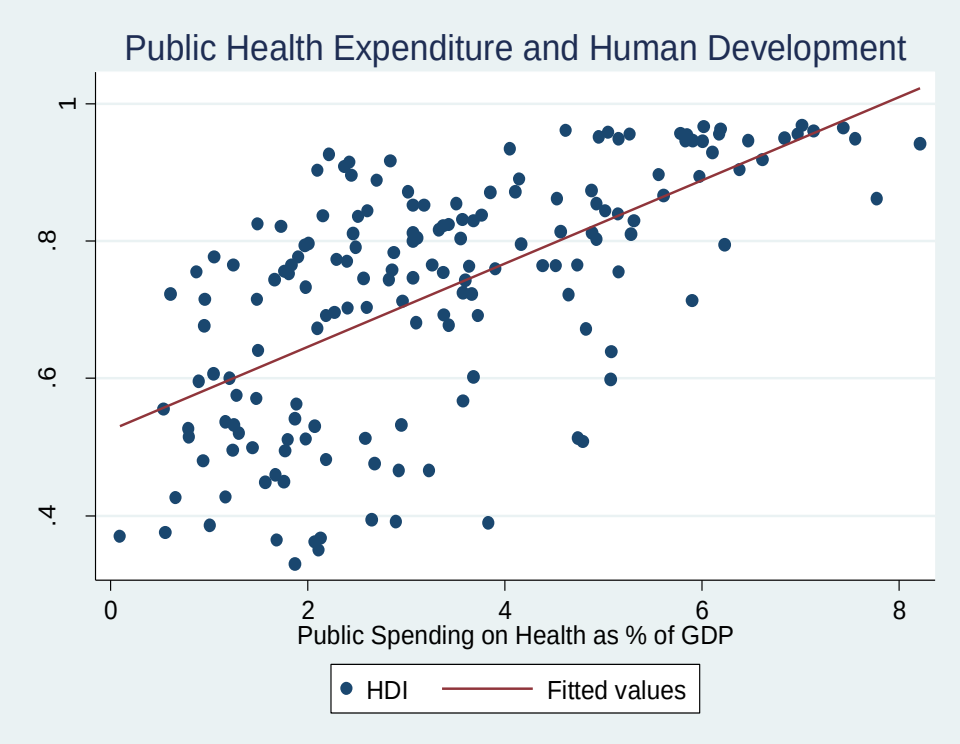


Figure 16

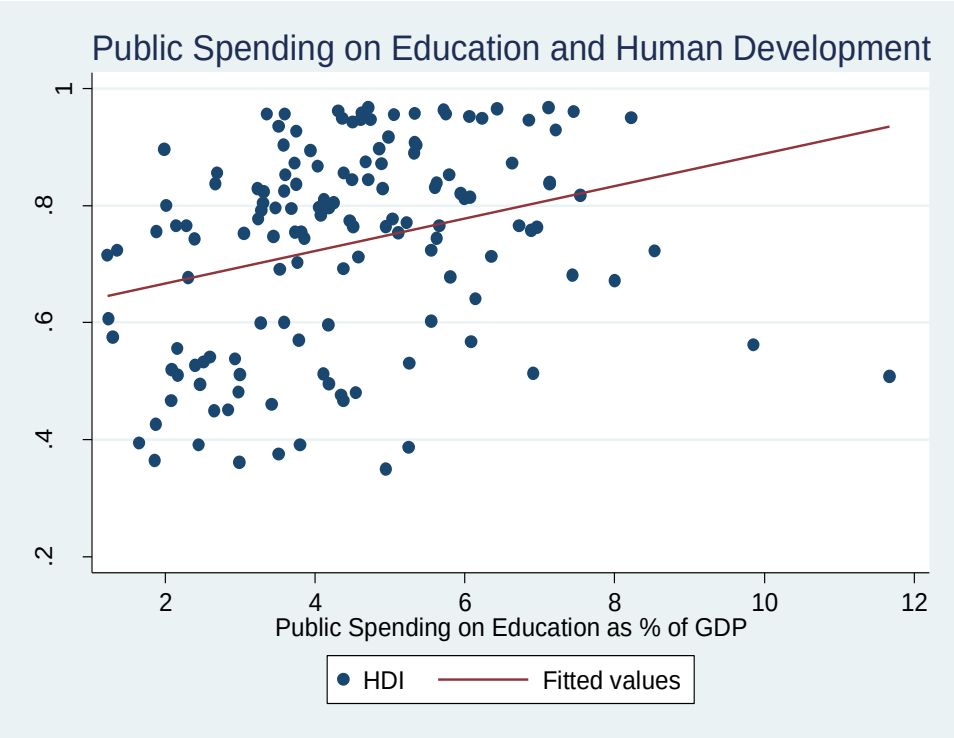


Figure 17

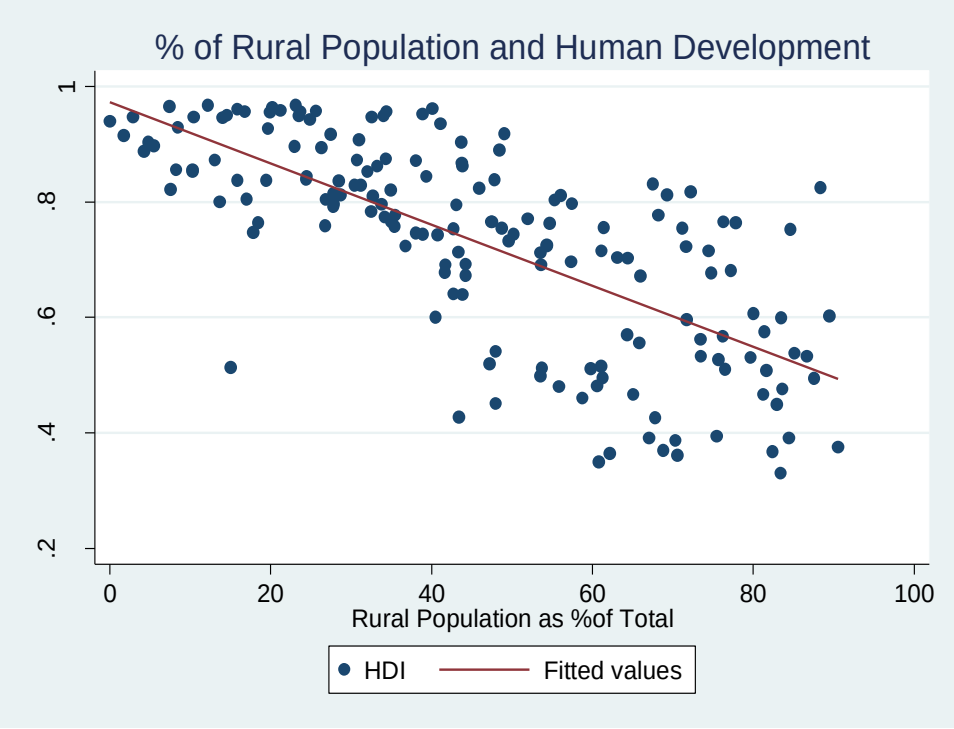


Figure 18

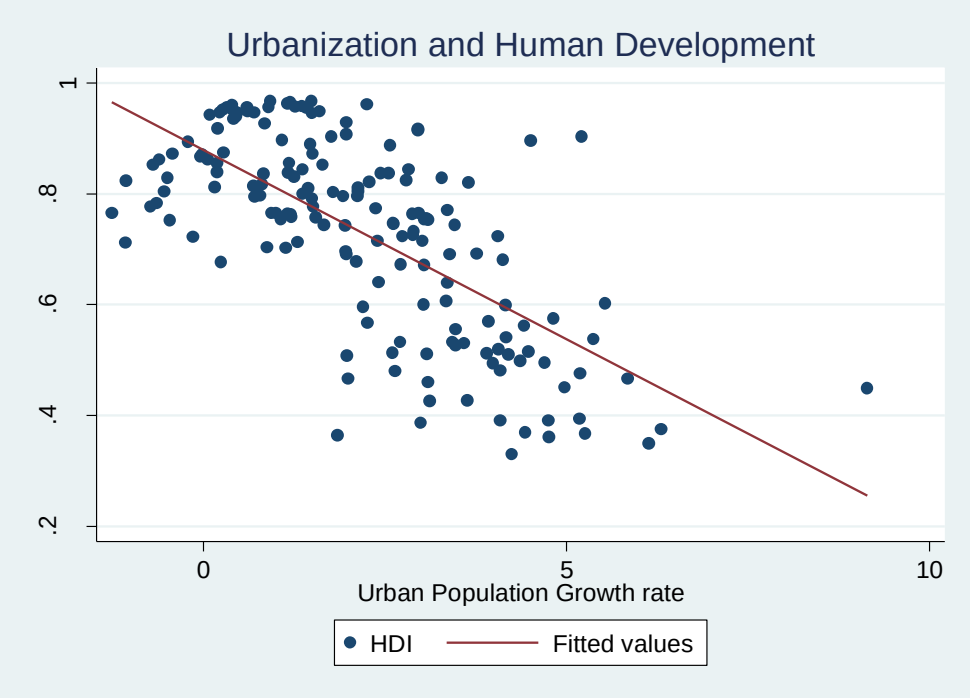


Figure 19

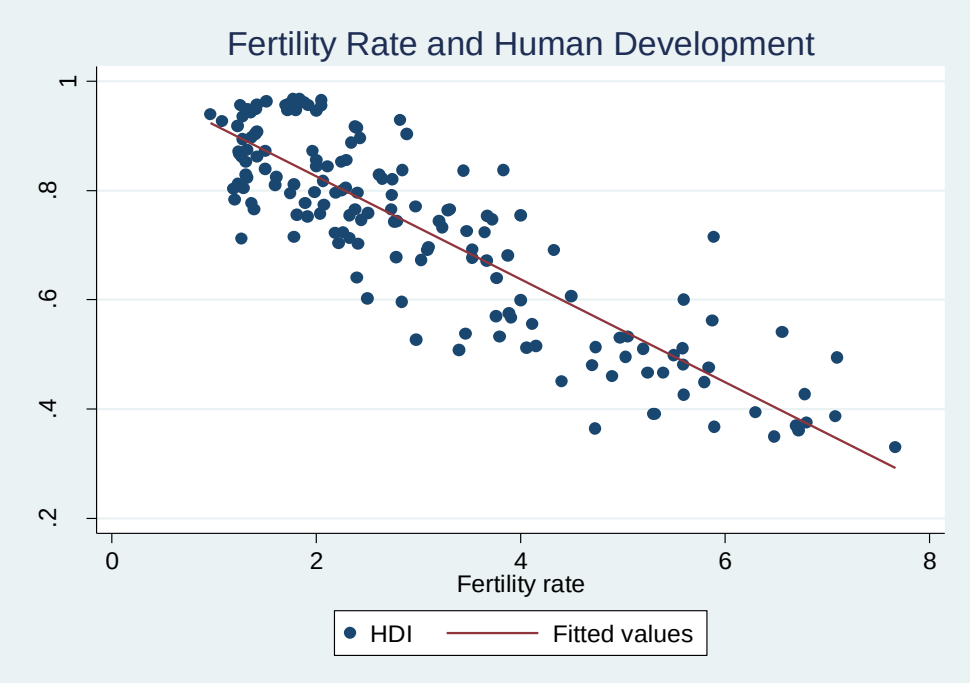


Figure 20

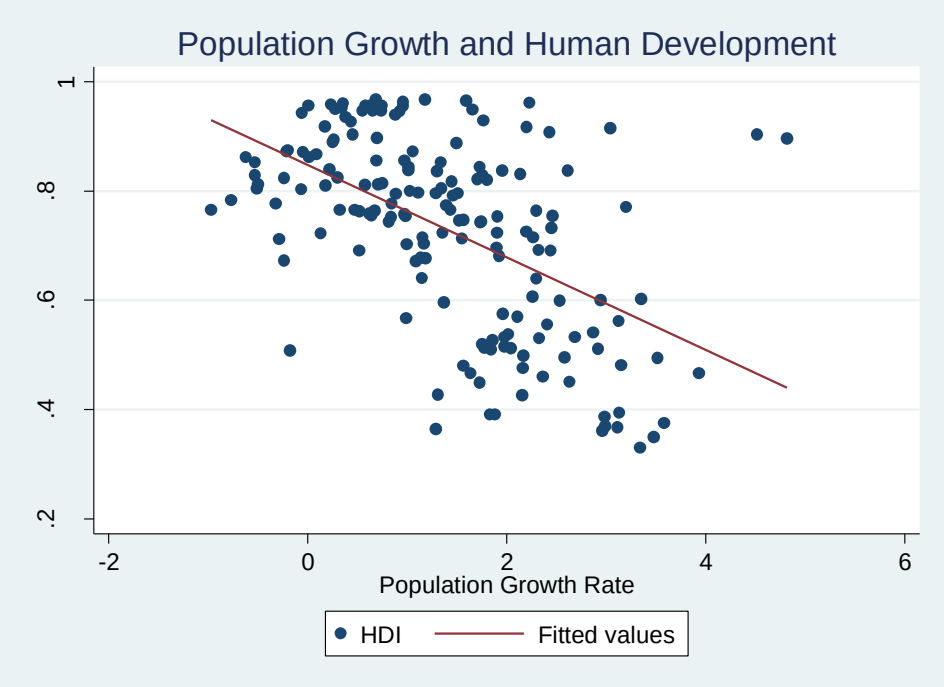


Figure 21

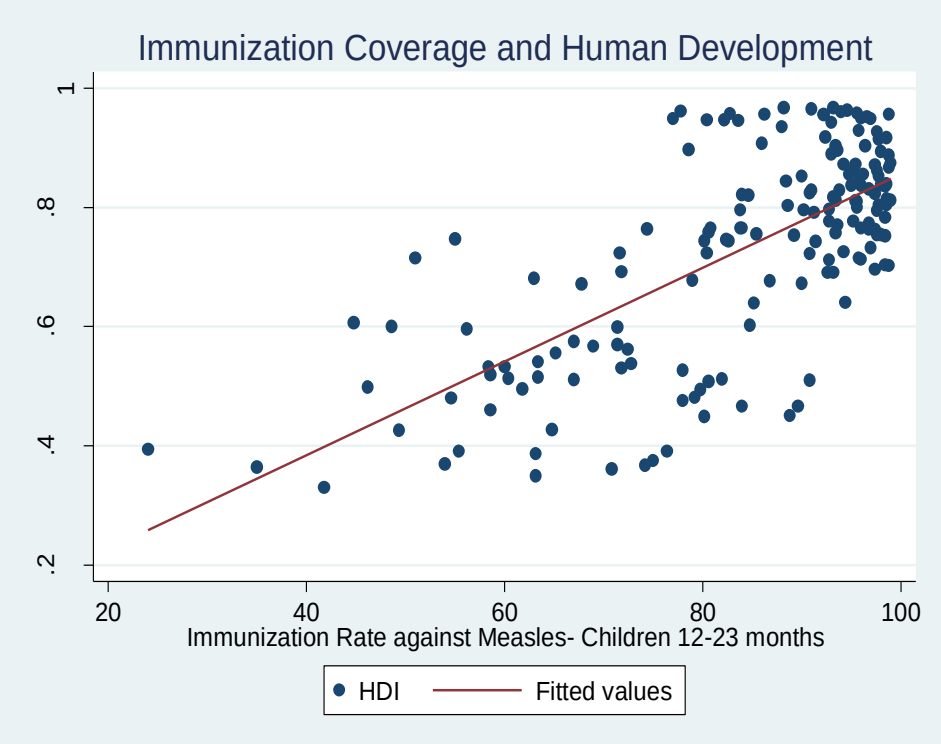
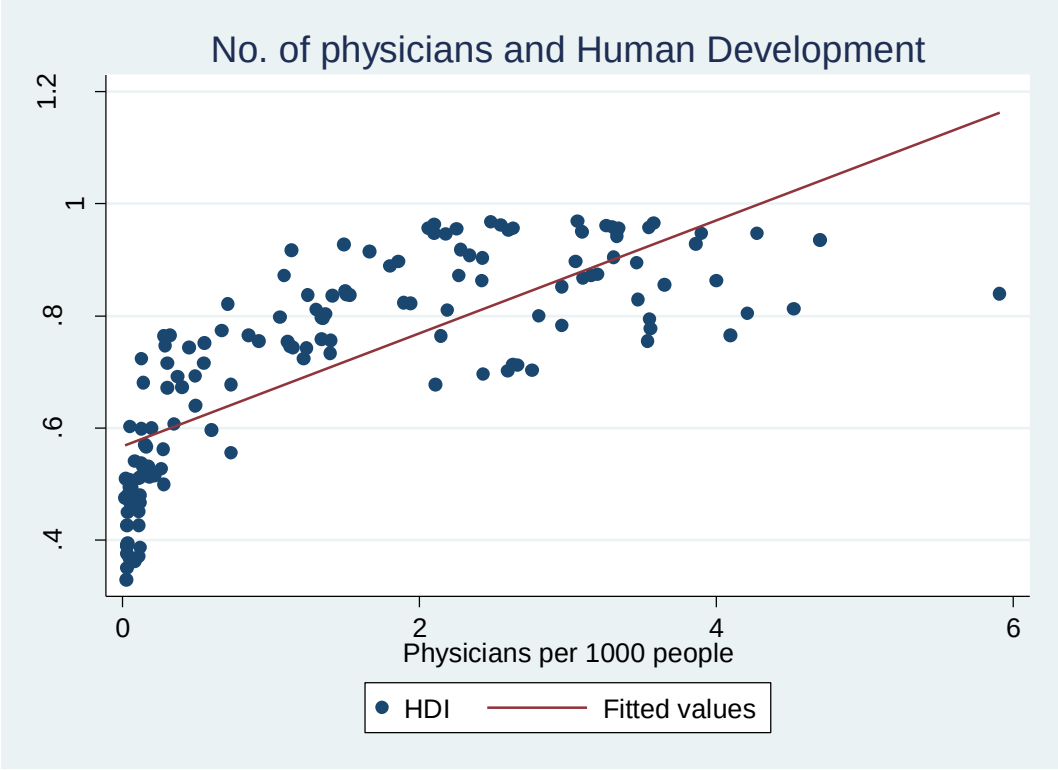


Figure 21


No. of physicians and Human Development
1.2
1
.8
.6
.4
0
2
4
6
Physicians per 1000 people
HDI
Fitted values

Appendix 2: Summary Statistics

Table 2.1

Variable	Obs	Mean	Standard Deviation	Min	Max
hdi	169	0.73	0.18	0.33	0.968
kgptemp	104	0.30	0.42	0	1
meantemp	101	19.94	7.73	-0.2	29.3
lwheatsugar	112	0.11	0.21	-0.39	0.58
eurfrac	101	0.25	0.40	0	1.004
colever	104	0.44	0.50	0	1
legbritish	162	0.35	0.48	0	1
legfrench	160	0.44	0.50	0	1
me	102	4.67	7.63	0	31.5479
avgkkz	157	-0.06	0.90	-1.77	1.94
polity2	147	3.91	6.42	-10	10
pengryc	169	2.90	3.50	-4.98	22.74
giniadj	119	42.27	9.01	23.97	67.46
ethnifrac	166	0.44	0.26	0	0.9302
hlthexp	167	3.34	1.82	0.09	8.21
eduexp	141	4.44	1.80	1.23	11.67
imdpt	168	84.62	15.91	21.8	99
physc	146	1.52	1.40	0.0155	5.91
urbnpopg	169	2.19	1.75	-1.26	9.14
fertrt	161	3.05	1.64	0.97	7.67
intub	169	141.31	1050.66	2.94	1050.66
ger	168	72	17.70	25.5	114.2
lie	164	68	10.34	44.5	82.7

Table 2.2: Summary statistics of key variables by level of human development

	LOW		MEDIUM		HIGH		VERY HIGH	
Variable	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
kgptemp	19	0.00	42	0.10	19	0.36	24	0.84
Mean	17	25.94	41	22.86	19	11.28	24	11.29
me	19	15.39	41	4.31	18	0.35	24	0.02
avgkkz	22	-0.85	69	-0.48	34	0.05	32	1.28
polity2	22	1.77	62	2.10	34	5.12	29	8.00
ethnifrac	22	0.72	68	0.47	41	0.39	35	0.26
pengryc	22	2.03	71	3.31	41	3.36	35	2.07
hlthexp	22	1.91	71	2.56	40	3.75	34	5.40
eduexp	19	3.33	57	4.38	34	4.54	31	5.12
urbnpopg	22	4.41	71	2.57	41	1.13	35	1.28
imdpt	22	65.73	71	80.68	41	93.90	34	93.89
physc	22	0.07	61	0.90	30	2.42	33	2.84
fertrt	22	5.78	68	3.42	37	1.97	34	1.72
giniadjnoc	14	46.76	48	45.04	29	41.63	28	35.95
lwheatsugar	14	0.01	48	-0.01	25	0.20	25	0.29

Appendix 3: Correlation Matrices

Table 3.1: Geography and Human Development Index (n = 99)

	hdi	meantemp	kgptemp	Me
hdi	1			
meantemp	-0.655	1		
kgptemp	0.703	-0.832	1	
me	-0.769	0.502	-0.460	1

Table 3.2: Regional Dummies and Human Development Index (n=169)

	hdi	regeap	regmena	regsa	regwe	Regssa	reglac
hdi	1						
regeap	0.088	1					
regmena	0.126	-0.126	1				
regsa	-0.133	-0.078	-0.070	1			
regwe	0.425	-0.126	-0.112	-0.070	1		
regssa	-0.762	-0.230	-0.205	-0.127	-0.205	1	
reglac	0.176	-0.175	-0.155	-0.097	-0.155	-0.284	1

Table 3.3: Colonial Legacy and Human Development (n=101)

	hdi	colever	eurfrac	legbritish	legfrench
hdi	1				
colever	-0.617	1			
eurfrac	0.498	-0.533	1		
legbritish	-0.076	0.189	-0.059	1	
legfrench	-0.202	0.078	0.117	-0.711	1

Table 3.4: Governance, Political Institutions and Human Development (n=142)

	hdi	avgkkz	va	ps	Ge	rq	Rl	coc	polity2	ethnifrac
hdi	1									
avgkkz	0.748	1								
va	0.652	0.911	1							
ps	0.553	0.832	0.720	1						
ge	0.772	0.979	0.873	0.759	1					
rq	0.759	0.959	0.887	0.721	0.953	1				
rl	0.737	0.975	0.831	0.784	0.964	0.921	1			
coc	0.708	0.958	0.814	0.749	0.948	0.892	0.965	1		
polity2	0.340	0.508	0.754	0.386	0.466	0.511	0.387	0.379	1	
ethnifrac	-0.571	-0.481	-0.447	-0.407	-0.47	-0.45	-0.475	-0.446	-0.282	1

Table 3.5: Human Development and Other Conditioning Variables

	hdi	pengryc	hlthexp	eduexp	fertrt	urbnpopg	imdpt	physc
hdi	1							
pengryc	0.03	1						
hlthexp	0.64	-0.15	1					
eduexp	0.27	-0.25	0.51	1				
fertrt	-0.86	-0.10	-0.52	-0.24	1			
urbnpopg	-0.67	-0.18	-0.43	-0.19	0.76	1		
imdpt	0.65	-0.03	0.44	0.29	-0.70	-0.47	1	
physc	0.77	0.19	0.56	0.20	-0.77	-0.72	0.578	1

Appendix 4: BMA Results

Table 4.1:
Dependent Variable HDI
Sample A (Without income inequality N=72)

Variable	Posterior inclusion probabilities	Sign	Posterior inclusion probabilities	Sign
Intercept	**1.00**	"+"	**1.00**	"+"
% of population living in KG Temperate Zone	**0.94**	"+"	0.14	"?"
Mean Temperature	0.22	"-"	0.01	"?"
Malaria Ecology	**0.26**	"-"	**0.98**	"-"
Sub Saharan Africa	**1.00**	"-"	**0.68**	"-"
South Asia	**1.00**	"-"	**1.00**	"-"
East Asia and Pacific	0.04	"?"	0.02	"?"
Latin America and Caribbean	0.04	"?"	0.19	"?"
Western Europe	**0.83**	"+"	0.01	"?"
Middle East and North Africa	0.06	"?"	0.01	"?"
Colony	0.16	"?"	0.05	"?"
British Colony	**0.90**	"+"	0.06	"?"
French Colony	0.09	"?"	0	"?"
Fraction of people speaking any European language	0.17	"?"	0	"?"
Governance Index (KKZ avg)			**0.77**	"+"
Polity 2			0.00	"?"
Ethnic fractionalization			0.06	"?"
Developing Country			**1.00**	"-"
Public Expenditure on health (% of GDP)			0.05	"?"
Public Expenditure on education (% of GDP)			0.07	"?"
Immunization against DPT			0.04	"?"
Fertility rate			**1.00**	"-"
Urbanization rate			**0.25**	"-"
Physicians			0.17	"?"

The dependent variable is *hdi*, the Human Development Index (2005). High values correspond to higher levels of Human Development. The numbers reported in the table are the posterior inclusion probabilities for each variable (the sum of posterior model probabilities for all models in which the variable is included). We also report an indicator of the direction of the relationship. (?) indicates an indeterminate sign.

Table 4.2:
Dependent Variable HDI (Sample B: with income inequality N=58)

Variable	Posterior inclusion probabilities	Sign	Posterior inclusion probabilities	Sign
Intercept	**1.00**	"+"	**1.00**	"+"
% of population living in KG Temperate Zone	**1.00**	"+"	0.02	"?"
Mean Temperature	0.06	"?"	0.09	"?"
Malaria Ecology	**0.84**	"-"	**1.00**	"-"
Sub Saharan Africa	**1.00**	"-"	**1.00**	"-"
South Asia	**1.00**	"-"	**1.00**	"-"
East Asia and Pacific	0.10	"?"	0.26	"+"
Latin America and Caribbean	0.10	"?"	0.02	"?"
Western Europe	**0.99**	"+"	0.07	"?"
Middle East and North Africa	0.11	"?"	0.01	"?"
Colony	0.06	"?"	0.01	"?"
British Colony	**0.90**	"+"	0.23	"+"
French Colony	0.10	"?"	0.12	"?"
Fraction of people speaking any European language	**0.30**	"+"	0	"?"
Governance Index (KKZ avg)			**0.90**	"+"
Polity 2			**0.78**	"+"
Ethnic fractionalization			0.00	"?"
Developing Country			**1.00**	"-"
Public Expenditure on education (% of GDP)			0.06	"?"
Public Expenditure on health (% of GDP)			0.06	"?"
Immunization against DPT			**0.99**	"+"
Fertility rate			**0.95**	"-"
Urbanization rate			**0.59**	"-"
Physicians			0.04	"?"
Gini (adjusted and averaged over 1960-98)			0.12	"?"

The dependent variable is *hdi*, the Human Development Index (2005). High values correspond to higher levels of Human Development. The numbers reported in the table are the posterior inclusion probabilities for each variable (the sum of posterior model probabilities for all models in which the variable is included). We also report an indicator of the direction of the relationship. (?) indicates an indeterminate sign.

Table 4.2:
Dependent Variable: Life Expectancy (Years)

N = 78						
Variable	**Posterior inclusion probabilities**	**Sign**	**Posterior inclusion probabilities**	**Sign**	**Posterior inclusion probabilities**	**Sign**
Intercept	**1.00**	"+"	**1.00**	"+"	**1.00**	"+"
% of population living in KG Temperate Zone	**1.00**	"+"	0	"?"	0.06	"?"
Mean Temperature	0.08	"?"	0.01	"?"	0.07	"?"
Malaria Ecology	**0.73**	"-"	**0.97**	"-"	**1.00**	"-"
Sub Saharan Africa	**1.00**	"-"	**0.95**	"-"	**0.97**	"-"
South Asia	**0.26**	"-"	0.06	"?"	0.07	"?"
East Asia and Pacific	0.11	"?"	**0.59**	"+"	**0.94**	"+"
Latin America and Caribbean	0.06	"?"	0.03	"?"	0.37	"+"
Western Europe	**0.51**	"+"	0.12	"?"	0.02	"?"
Middle East and North Africa	0.07	"?"	0	"?"	0.05	"?"
Colony	0.05	"?"	0.02	"?"	0.05	"?"
British Colony	0.06	"?"	0.04	"?"	0.02	"?"
French Colony	0.06	"?"	**0.73**	"+"	**0.98**	"+"
Fraction of people speaking any European language	**1.00**	"+"	0.07	"?"	0.06	"?"
Governance Index (KKZ avg)			**0.96**	"+"	0	"?"
Polity 2			0.01	"?"	0.02	"?"
Ethnic fractionalization			0.01	"?"	0.06	"?"
Public Expenditure on health (% of GDP)			0.10	"?"	0.00	"?"
Incidence of Tuberculosis			**1.00**	"-"	**1.00**	"-"
Immunization against DPT			0.09	"?"	**0.97**	"+"
Fertility rate			**1.00**	"-"	**1.00**	"-"
Gross Enrolment Ratio			**0.48**	"+"	0.06	"?"
Gini (adjusted and averaged over 1960-98)			0.02	"?"	0.11	"?"
Real GDP per capita					**1.00**	"+"

The dependent variable is *lie*, the Life Expectancy (2005). The numbers reported in the table are the posterior inclusion probabilities for each variable (the sum of posterior model probabilities for all models in which the variable is included). We also report an indicator of the direction of the relationship. (?) indicates an indeterminate relationship.

Table 4.2:
Dependent Variable: Combined Gross Enrolment Ratios

N = 66						
Variable	**Posterior inclusion probabilities**	**Sign**	**Posterior inclusion probabilities**	**Sign**	**Posterior inclusion probabilities**	**Sign**
Intercept	**1.00**	"+"	**1.00**	"+"	**1.00**	"+"
% of population living in KG Temperate Zone	**1.00**	"+"	**0.97**	"+"	**0.99**	"+"
Mean Temperature	0.05	"?"	0.01	"?"	0	"?"
Malaria Ecology	**0.66**	"-"	**0.96**	"-"	**0.98**	"-"
Sub Saharan Africa	**0.95**	"-"	**0.39**	"-"	0.19	"?"
South Asia	**0.98**	"-"	**0.37**	"-"	0.12	"?"
East Asia and Pacific	0.15	"?"	**0.68**	"+"	**0.95**	"+"
Latin America and Caribbean	**0.51**	"+"	**0.66**	"+"	**0.95**	"+"
Western Europe	**0.34**	"+"	0.16	"?"	0.04	"?"
Middle East and North Africa	0.09	"?"	0.06	"?"	0.13	"?"
Colony	0.04	"?"	0	"?"	0	"?"
British Colony	**0.95**	"+"	**0.35**	"+"	0.07	"?"
French Colony	0.09	"?"	0.05	"?"	0.05	"?"
Fraction of people speaking any European language	0.12	"?"	0.04	"?"	0.01	"?"
Governance Index (KKZ avg)			**0.75**	"+"	0.08	"?"
Polity 2			**0.93**	"+"	**0.98**	"+"
Ethnic fractionalization			0.09	"?"	0.10	"?"
Public Expenditure on education (% of GDP)			**0.47**	"+"	**0.36**	"+"
Immunization against DPT			0.6	"+"	**0.93**	"+"
Fertility rate			0.16	"?"	**0.30**	"+"
Gini (adjusted and averaged over 1960-98)			0.00	"?"	0.01	"?"
Undernourishment rate			0	"?"	0	"?"
GDP per capita					**0.93**	"+"

The dependent variable is *ger*, the Gross Enrolment Ratios (2005). The numbers reported in the table are the posterior inclusion probabilities for each variable (the sum of posterior model probabilities for all models in which the variable is included). We also report an indicator of the direction of the relationship. (?) indicates an indeterminate sign.

Table 4.3: OLS Results

Dependent Variable: HDI		
Intercept	0.944***	0.862***
	(-19.02)	15.29
% of population living in KG Temperate Zone	-0.062	-0.019
	(-1.82)	(-0.71)
Malaria Ecology	-0.004***	-0.004***
	(-3.98)	(-4.22)
Sub Saharan Africa	-0.058	-0.088
	(-1.18)	(-1.88)
South Asia	-0.125***	-0.118***
	(-4.64)	(-3.84)
Latin America and Caribbean	0.017	0.006
	(0.79)	(0.32)
East Asia and Pacific	0.034	0.030
	(1.86)	(1.56)
Western Europe	0.001	0.005
	(0.05)	(0.27)
British Colony	0.037*	0.0309
	(2.07)	(1.61)
French Colony	0.019	0.016
	(1.36)	(1.14)
Governance Index (KKZ avg)	0.043**	0.048***
	(2.51)	(2.8)
Polity 2	0.001	-0.001
	(-0.91)	(-0.41)
Developing Country	-0.067**	-0.047*
	(-2.83)	(-1.98)
Fertility rate	-0.042***	-0.036***
	(-3.64)	(-2.65)
Urbanization rate	-0.015	-0.012
	(-1.78)	(-1.35)
Physicians	0.027	0.018*
	(2.39)	(2.02)
Gini (adjusted and averaged over 1960-98)		0.001
		(0.65)
N	**72**	**62**
Rsquared	**0.9524**	**0.9624**

Numbers reported in parentheses are t statistics computed from heteroskedasticity-robust standard errors
* p≤0.05, ** p≤0.01, *** p≤0.001

Table 4.4: OLS Results

Dependent variable: Life Expectancy		
Intercept	71.064***	45.526***
	(16.62)	(5.11)
% of population living in KG Temperate Zone	0.607	0.177
	(0.4)	(0.13)
Malaria Ecology	-0.205**	-0.223**
	(-3.01)	(-3.23)
Sub Saharan Africa	-3.160	-1.722
	(-1.6)	(-0.91)
South Asia	1.094	2.403
	(0.61)	(1.85)
Latin America and Caribbean	1.470	1.302
	(1.27)	(1.28)
East Asia and Pacific	2.921*	3.057**
	(2.41)	(3.15)
Western Europe	2.077*	1.364
	(1.96)	(1.49)
British Colony	0.490	-0.343
	(0.49)	(-0.44)
French Colony	1.864*	1.253
	(2.15)	(1.7)
Governance Index (KKZ avg)	1.470*	0.174
	(2.12)	(0.2)
Fertility rate	-1.484***	-0.882*
	(-3.65)	(-2.28)
Urbanization rate	0.158	0.209
	(0.53)	(0.8)
Immunization rate against DPT	0.034	0.055*
	(1.31)	(2.03)
Incidence of Tuberculosis	-0.022***	-0.022***
	(-4.67)	(-4.34)
Gross Enrolment Ratio	0.047	0.020
	(1.38)	(0.65)
Gini (adjusted and averaged over 1960-98)	-0.046	-0.020
	(-0.89)	(-0.45)
Log of Real GDP per capita		2.667**
		(2.97)
N	**78**	**78**
Rsquared	**0.9631**	**0.971**

Numbers reported in parentheses are t statistics computed from heteroskedasticity-robust standard errors
* p≤0.05, ** p≤0.01, *** p≤0.001

Table 4.5: OLS Results

Dependent variable: Gross Enrolment Ratios	
Intercept	21.938
	(0.75)
% of population living in KG Temperate Zone	16.769***
	(4.21)
Malaria Ecology	-0.547***
	(-3.61)
Sub Saharan Africa	-10.456*
	(-2.01)
South Asia	-7.622
	(-1.14)
Latin America and Caribbean	6.086
	(1.72)
East Asia and Pacific	8.125*
	(2.26)
Western Europe	3.703
	(1.35)
British Colony	5.331*
	(2.02)
French Colony	3.056
	(1.35)
Governance Index (KKZ avg)	1.885
	(0.87)
Polity 2	0.636***
	(4.7)
Fertility rate	2.633
	(1.72)
Urbanization rate	-0.144
	(-0.15)
Immunization rate against DPT	0.203**
	(2.86)
Public Expenditure on education (% of GDP)	0.656
	(1.08)
Undernourishment rate	0.048
	(0.41)
Log of Real GDP per capita	1.577
	(0.58)
N	**66**
Rsquared	**0.9177**

Numbers reported in parentheses are t statistics computed from heteroskedasticity-robust standard errors
* p≤0.05, ** p≤0.01, *** p≤0.001